NEB Experience with GHGs and Pipeline EA[1]

Usha Mulukutla, Marcus Eyre, Zoe Pfeiffer, Laura Randall

As Canada's federal energy regulator, the National Energy Board (NEB or Board) has oversight of over 73,000 km of interprovincial and international pipelines in Canada. In regulating energy infrastructure, the NEB promotes safety, security, and environmental protection, in the Canadian public interest.

Proponents of new pipeline projects must apply to the NEB. The Board conducts an environmental assessment (EA) under the *National Energy Board Act* (NEB Act) and for larger projects, under the *Canadian Environmental Assessment Act, 2012* (CEAA 2012). Under CEAA 2012, the NEB must recommend whether a project is likely to cause significant adverse environmental effects (after taking into account mitigation measures and any conditions of approval), and if so, whether the effects are justified.

The NEB requires applicants to file information on greenhouse gas emissions (GHGs) associated with projects. Guidance now commonly recognizes two areas that should be addressed in EA: mitigation of GHG emissions, and adaptation to climate change (Ohsawa and Duinker, 2014).

This paper focuses on the consideration of GHG emissions from pipeline projects. NEB EAs in which GHG emissions were an issue were reviewed[2] to identify key issues and questions: sources of emissions and their quantification, regulatory conditions, significance determination, and EA scoping.

Sources and quantification of GHGs

The NEB focuses primarily on GHGs directly emitted by projects. Since construction and operation sources differ and have unique quantification methods, regulatory requirements, and mitigation options, distinct conclusions must be made for both project phases.

During project construction, GHG emissions generally stem from land clearing, biomass burning, and operation of construction equipment. Quantification of equipment emissions range from 100 to 250 t CO_2e/km of pipeline constructed, with an average of 175 t CO_2e/km, depending on variables such as terrain and season. Clearing-related emissions are more difficult to characterize and have ranged from 4.3 t CO_2e/km in cropland to 911.3 t CO_2e/km in coastal rainforest, and based mainly on fuel loading assumptions for the ecotype and hectares to be cleared, minus any salvageable timber.

In contrast, operational emissions cannot be compared across projects as they vary based on throughput capacity, individual design, and component counts. For natural gas pipeline operations, compressors are typically the largest direct GHG emission source. Other operational sources are associated with maintenance and inspection activities (including aerial patrols),

[1] The views, judgements, opinions and recommendations in this paper are those of the authors alone and do not necessarily reflect those of the NEB, its Chair or Members.
[2] Based on applications received between 2008-2016.

heating at facilities, and fugitive emissions from valves, connectors, pumps, and tanks. For oil pipelines, electrically driven pumps result in indirect GHG emissions, which would be reported by a power utility and subject to provincial regulation.

When preparing quantification estimates, proponents factor in their proposed mitigation measures. For example, when estimating construction vehicle run-time hours, mitigation to reduce those hours (e.g., using buses to move crews) are taken into account. For operational estimates, best practices for design, equipment selection, leak detection, and corporate offsetting commitments are typically incorporated.

Mitigation effectiveness varies widely. For example, reducing vehicle idling typically contributes little to overall emission reductions. In contrast, experience suggests that the largest long-term reductions typically come from appropriate facility design given the long lifecycle of energy facilities.

The role of regulatory conditions

NEB EAs often identify mitigation gaps and generate recommendations for further mitigation. If a project is approved, the NEB imposes regulatory conditions to ensure the sufficiency, certainty and effectiveness of mitigation.

For example, the 2003 Georgia Strait Crossing (GSX) Project, in which BC Hydro proposed a natural gas pipeline to generating stations on Vancouver Island, was one of the first NEB hearings in which GHGs were raised as a public concern. Although BC Hydro committed to offset some of its GHGs voluntarily, the Panel imposed a condition making it a binding requirement to track the offsets through an annual report (NEB, 2003).

In 2010, the approval of the Canadian portion of the Keystone XL pipeline included a requirement for a quantitative assessment of all project-related GHG emissions in order to provide greater transparency and accountability (NEB, 2010). Since then, the Board has continued to require quantitative GHG assessments and has sometimes also required post-construction verification of the assumptions used in the initial calculations. Over the years, these have shown that the assumptions used in the estimates (e.g., amount of salvageable timber, equipment run-time hours) are sufficiently conservative to overestimate the predicted emissions as compared with the actual emissions.

Beyond design-based mitigation and reporting of emissions, a benefit of having a regulator conduct EAs is the ability to require best practices over the life of project operations. For example, in 2015 an application to re-route part of the Alliance pipeline included the venting of gas from a 30 km segment of the pipeline. Instead, the Board directed Alliance to flare the gas, avoiding approximately 16,200 tonnes CO_2e (NEB, 2016). This was in line with Board requirements to explore alternatives to venting (i.e., flaring/incineration, or draw-down compressors). Estimates have shown up to 80 per cent reductions in GHG emissions when such alternatives prove feasible.

Offsets are the final mitigation option for any unavoidable emissions. In the Trans Mountain Expansion Project (TMX), given the volume of construction-related emissions (approximately 890,000 t CO_2e) and that these are not reportable under federal GHG regulations, the Board imposed an offset requirement to confirm no-net increase in construction emissions (NEB, 2016).

Significance criteria and determination

Once emission sources, proposed mitigation, and potential regulatory conditions are accounted for, the significance of residual emissions must be assessed. Some proponents have recently used methods to calculate the effects of project GHG emissions on climate change indicators. Estimated project effects on global rainfall or crop yield, for example, are minute and highly uncertain in time and location, and so do not meaningfully inform an EA. In the Keystone XL and TMX projects both Panels noted the distinction between the emissions and the climate change effects, as is now common practice in EAs.

Since several of the criteria typically used for evaluating significance stay constant for GHG emissions (i.e., global in spatial extent and irreversible in temporal extent), the magnitude and duration criteria are key in assessing significance. For construction-related GHG emissions, proponents often rely on the short-term duration of the emissions in proposing significance. Given that construction-related emissions are not reportable federally, proponents have assessed potential significance through comparison to other, similar projects.

Operations-related emission estimates are often compared with provincial and national emission inventories, as Canada does not currently have facility-level GHG emission standards. By comparing a project's emissions to the total national or provincial inventories, the incremental addition is often small. As a more useful comparison, the Board has required proponents to compare emissions estimates to sector-specific industry profiles (NEB, 2010, 2016). Provincial and federal reporting thresholds for operations-related emissions have also been considered in determining significance.

Ultimately what is assessed is the amount or volume of GHG emissions. In determining significance, the challenge is inherently one of cumulative effects: new projects continue to be developed, with additional contributions (however small) to existing global GHG levels that are already significant. Consequently, a broader policy framework is necessary if EAs are to provide consistent and meaningful significance determinations.

Scoping

A recurring issue around pipeline GHGs is whether to consider related facilities. In the GSX hearing noted above, the Panel heard argument on whether it could consider the environmental effects from downstream combustion emissions[3]. Ultimately the Panel explained that because of the direct linkage it should only consider the effects from the proposed new power facility but not from an already operating facility.

[3] under the CEA Act or the NEB Act

Various Panel reviews have since considered similar scoping scenarios and came to similar conclusions (NEB, 2013; 2014; 2015). This approach and rationale has been challenged in the courts and twice been found to be reasonable[4]. Consistent with these decisions, the NEB's Filing Manual explains that the environmental and socio-economic effects in Canada of upstream or downstream facilities may be considered where there is a necessary connection between those facilities and the project.

In early 2016 the Government of Canada, as part of its review of federal EA, announced interim principles for ongoing project EAs, including that upstream GHG emissions not directly linked to a project would be assessed. Environment and Climate Change Canada (ECCC) has completed a number of these[5] following a two-part methodology. In Part A, ECCC provides a quantitative estimation of the associated upstream emissions using data related to product mix and emission factors reflecting extraction and processing methods. Part B discusses the conditions under which the upstream emissions would occur regardless of the project. Part B includes production forecasts given various price scenarios, potential alternative markets and modes of transportation, and other market conditions. Part B highlights the relationship between environmental assessment and economic assessment. For example, global hydrocarbon production can respond to changes in Canadian production, and continental hydrocarbon transportation alternatives such as rail can respond to regional limitations in pipeline capacity.

Conclusions

The Board's assessment of GHG emissions in project EAs has evolved along with the growing public concern regarding energy infrastructure and climate change. This has led to in increasing requirements for GHG quantification and mitigation, including offsetting of unavoidable emissions, within the current legislative framework.

Canadians expect climate change to be considered during energy infrastructure assessments. The challenges are significant and persistent. Going back to 2010 the Mackenzie Gas Project's Joint Review Panel noted that GHG emissions issues "cannot be resolved on a project-by-project basis through the environmental assessment process, but must be addressed by governments through comprehensive climate change strategies."[6]

Overall, three main findings can be drawn from the review presented in this paper:

1. With respect to direct emissions, project-based EAs are useful and effective in identifying, evaluating and mitigating project-level GHG emissions. They are particularly beneficial when conducted by a regulator such as the NEB with a mandate to enforce

[4] See Sumas Energy 2, Inc. v. Canada, 2005 FCA 377; Forest Ethics Advocacy Association and D. Sinclair v. the NEB, Canada (A-G) and Enbridge Pipelines Inc., 2014 FCA 245
[5] As of date, 2 for oil pipelines, 2 for gas pipelines and 2 for LNG facilities.
[6] JRP Report for the Mackenzie Gas Project (A1R2L6)

conditions and regulations that drive emission reductions over the operating life of a project.

2. Emissions from upstream or downstream sectors present a major policy issue that challenges the current project-based EA framework. Regardless of whether an EA is conducted by a regulatory agency or a separate body, important questions need to be resolved. For example, how do EAs and the assessment of GHGs fit within broader government EA legislation (including other jurisdictions and duplication of EAs), climate change policy and decarbonization of Canada's energy systems?

3. Finally, for both direct and indirect GHG emissions, a broader policy framework is needed to clarify "significance". The NEB's experience is consistent with Ohsawa and Duinker's (2014) finding of ambiguous or inconsistent definitions of significance and recommendation for "clear and reasonable" definitions. What is the standard that proponents are expected to meet, and how are EA conclusions regarding GHG emissions to be coherent between assessments?

The issues around pipeline GHG assessments reflect fundamental questions about EA in general in Canada: What should EA be? And what is its role within government's broader legislative and policy framework?

References

Ohsawa T, Duinker, P. 2014. Climate-change mitigation in Canadian environmental impact assessments. *Impact Assessment and Project Appraisal*. *32(3): 222-233*.
NEB, 1988. Reasons for Decision, Alliance Pipeline Project (GH-3-97)
NEB, 2003. Reasons for Decision, Georgia Strait Crossing Pipeline Limited on behalf of GSX Canada Limited Partnership (GH-4-2001)
NEB, 2010. Reasons for Decision, TransCanada Keystone XL Pipeline (OH-1-2009)
NEB, 2013. Procedural Update No. 1, Enbridge application for Line 9B reversal and Line 9 Capacity Expansion Project, OH-2-2013 (A3G6J4)
NEB, 2014. Ruling No. 25, 2014. Trans Mountain Expansion Project, OH-001-2014 (A3Z514)
NEB, 2015. Report, NOVA Gas Transmission Ltd. North Montney Project, GH-001-2014 (A69520)
NEB, 2016. Letter and Orders XG-A159-010-2016 & MO-012-2016 to Alliance Pipelines Ltd. Regina South Bypass Mainline Upgrade. (A76653-1)
NEB, 2016. Report, Trans Mountain Expansion Project (A77045)

What matters is more important that what counts: Qualitative approaches to social impact assessment (SIA)

By Jane Munday, PhD Candidate with the Northern Institute, Darwin, Australia

Abstract

This paper offers a concept of social licence to operate as the space between a project's legal licence and society's expectations. It explores the difference between a regulatory compliance-based approach to social impact assessment and qualitative participation that builds an understanding of a community's lived experience, aspirations and values, which is particularly important for projects proposed on Aboriginal land.

Introduction

We live in an era of contested spaces, polarised opinions and argumentative debate fanned by social media. Citizens want more say about development on their land and impacts on their neighbourhoods, hence a growing focus on meaningful public participation to better capture the social impacts of projects.

Social impacts are described by Vanclay (2003) as changes to people's way of life, their culture, their community, political systems, environment, health and wellbeing, personal and property rights and their fears and aspirations. Understanding how a project or policy impacts on these dimensions requires quality time as opposed to the use of 'simplistic tools', linear approaches and aggregate statistics to characterise an affected community (Howitt, 2011) or producing an "opus that will extract a pass mark for least effort" (Harvey, 2011).

Public participation

Public participation has been described as "a little like eating spinach: no one is against it in principle because it's good for you" (Arnstein, 1969). However, in the author's experience, participation often has little influence on project decisions, leading to cynicism and consultation fatigue.

What, then, are the elements of qualitiative participation, rather than a quantitative process that counts meetings, fact sheets and stakeholders? They include story-telling or grounded questions to understand community values, deliberation to engage people in dialogue rather than debate, scenario planning to guide best-guess predictions of uncertain futures and strategic assessment to consider regional and cumulative impacts. The foundations are time, trust, relationships and listening skills: attributes often in conflict with the time constraints, culture and regulatory approaches.

Social licence to operate

A social licence to operate is "society's expectations regarding the rights granted to a business to use land, its natural and mineral resources and the reciprocal responsibilities and accountability of the business to society" (Preston, 2014) or the "level of acceptance or approval of the activities of an organization by its stakeholders, especially local impacted communities" (Vanclay et al., 2015). Preston presents a model where the space between a company's legal and social licence to operate flexes with its ability to satisfy society's expectations. A social licence is influenced by the values, beliefs, emotions, perceptions and aspirations of real people. It will be granted when a community feels listened to and understood, has confidence and trust in relationships formed with companies and can see an equitable distribution of impacts and benefits.

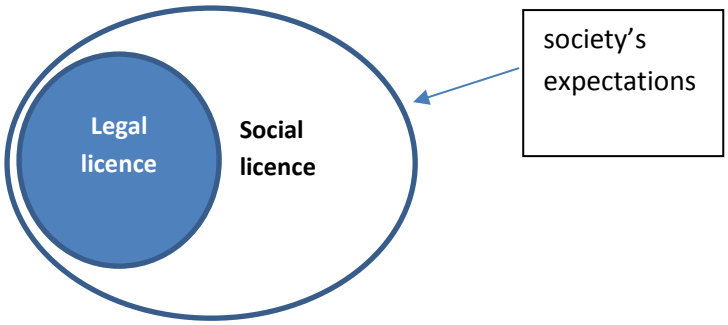

Fig 1: The gap between a legal licence and society's expectations (Preston, 2014).

Preston's model is amended by the author (Fig. 2) to consider the gap between a legal licence and society's expectations as a qualitative working space where public participation will contribute to wise decisions and environmentally, economically, culturally and socially sustainable projects. Technical studies and quantitative data may be sufficient for straight-forward projects. Analysis of baseline data contributes to scoping for more qualitative studies. Quantitative studies are necessary, but rarely sufficient, however, when dealing with complex, emotive and disruptive projects.

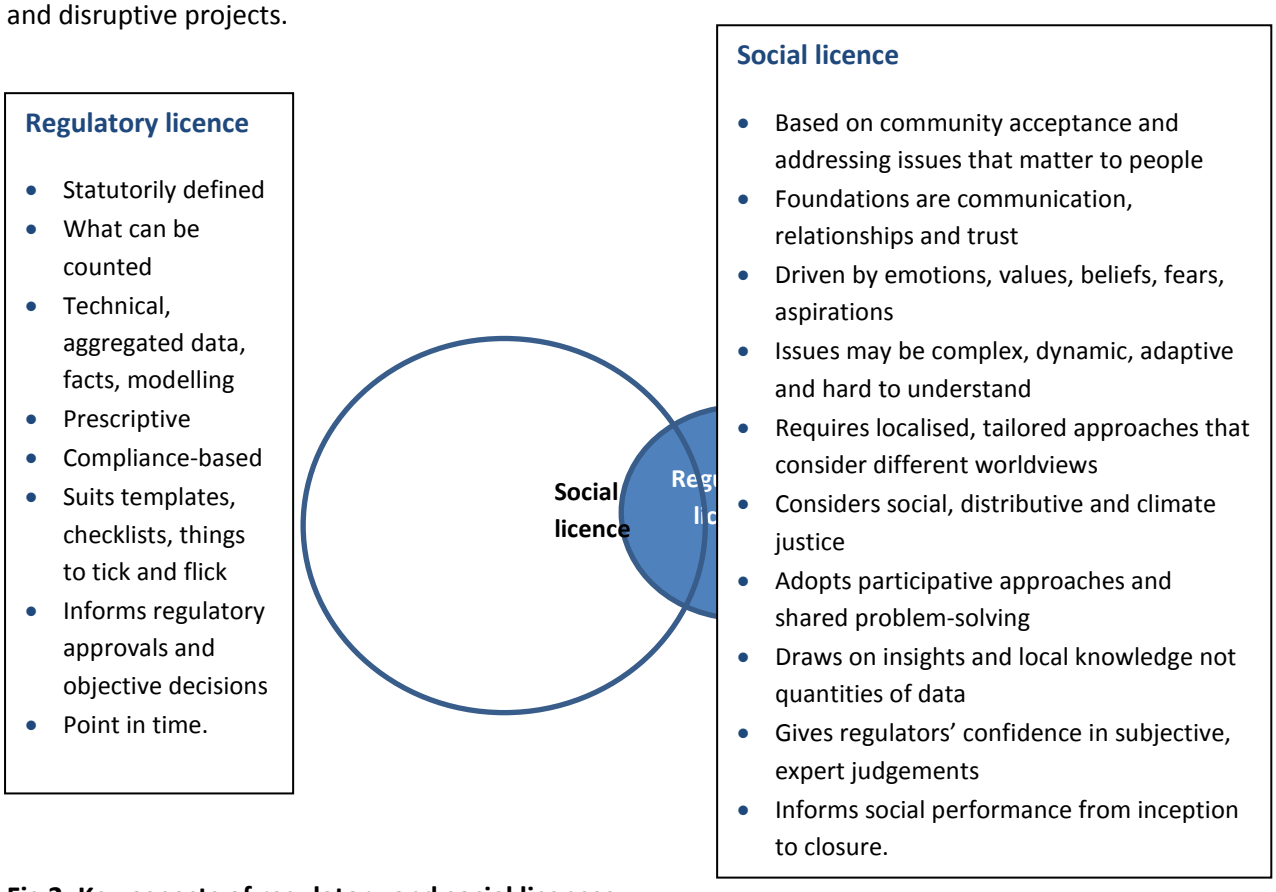

Fig 2: Key aspects of regulatory and social licences

Is democracy off the rails? Can deliberation help?

What do qualitative approaches to SIA and public participation contribute to the 21st Century burning deck: democracy in turmoil? Why are elections throwing up populist, argumentative autocrats? Why is it that the more we argue, the more we disagree: what James Hoggan refers to as the 'polluted public space' (Hoggan, 2016)? To understand why – and when - citizens take strong positions on issues, we have to consider the values and self-interest that underlie these positions. What we think

of Donald Trump will depend our beliefs, the values we will fight to defend (sustainability, respect, social justice) or whether we just feel abandoned, jobless, threatened by diversity and mourn for the good old days?

The more people howl outrage at Donald Trump, the more his popularity rises with those espousing opposing values. Outrage is like a foxhole: we dig ourselves deeper and deeper, look for information to confirm our righteous beliefs and bond closer to the rest of what is now our 'tribe'. Deliberation, on the other hand, coaxes us out of our foxholes – or gets us talking civilly to each other before we become an angry tribe – into a space where we can explore, engage in dialogue with people unlike ourselves, find shared values and interests and consider how to resolve our differences.

Parkin and Mitchell (2005) have explored the application of deliberative approaches to SIA and compare deliberative spaces with more episodic forms of democratic participation which may be limited to 'sound bites' and popularity contests. They draw on a definition of deliberative democracy as "debate and discussion aimed at producing reasonable, well-informed opinion in which participants are willing to revise preferences in light of discussion, new information, and claims made by fellow participants" (Chambers, 2003). Mitchell and Leach (2015) draw on Tobin's DIKW hierarchy (data-information-knowledge-wisdom) to outline how a deliberative team approach provides multidisciplinary learning.

Deliberation and narrative also explore values. Exploring environmental, cultural, spiritual, economic and social values helps us predict reactions to a project and the strength of positions for or against. Values include respect for distributive, social, climate and procedural justice and human rights, none of which can be counted.

What counts or what matters?

Baseline studies for impact assessment in Australia typically draw on Australian Bureau of Statistics (ABS) data. While this provides a starting point for characterising an area of study, there are many deficiencies in aggregated data, not the least of which is that it is often outdated and does not capture diversity, perceptions and matters of concern. It doesn't account for the principle of subsidiarity: the closer people live to a problem, the more likely they are to have solutions and should be involved in decision-making (Vanclay et al., 2015; Surowiecki, 2005).

Take a family living a quiet rural lifestyle next to a proposed mine. This family might be a statistical outlier or match the average demographic 'person' in the region. Dust modelling might indicate no amenity impacts on this 'nearest receptor'. But it doesn't tell us that the owners are fourth-generation farmers whose blood, sweat and tears are in the soil along with the ashes of their beloved son and the social, cultural and spiritual connections to place that may elevate their reactions to a social media storm.

Data should be relevant to the issues that emerge in the initial scoping of a social impact study rather than constituting a 'data dump', such as irrelevant statistics on childcare places in the nearest town - when the project is likely to rely on FIFO workers. What's more, consideration of gendered and cultural impacts looks at workforce issues for women (as workers and in their role as caregivers if partners leave the community for work) and cultural norms with childcare. In some Aboriginal communities, it is the extended family unit that takes on childcare, with 'grannies' bearing the burden (Austin-Broos, 2009). It may be culturally inappropriate for other families to look after these children.

Data doesn't deal well with the future, the sort of scenario analysis that probes the indirect impacts of demographic and neighbourhood change. It doesn't capture aspirations, fears and perceptions. Most of all, what can be counted and measured is often not what matters most. For example, an analysis of the role of traditional knowledge in a Canadian impact study (Stevenson, 1996) observed that the First Nations hunters didn't count caribou so much as observe their health and behaviour, because that's what is important for hunting.

To draw on the case study of a fairly typical mining project going through its regulatory approvals in Central Australia:

- Groundwater is a key issue of the impact assessment and modelling suggests no detrimental impact on bore water. However, the local people describe issues with water pressure that turn out to be caused by an antiquated pumping system not declining aquifers (this insight led to a focus on communicating water issues during consultation).
- Data (ABS 2011) suggests a nearby township of about 120 mostly non-Aboriginal residents with no children (but a busy school with all Aboriginal children), no unemployment in an area with 20% Aboriginal unemployment and virtually no public housing, but everyone renting – the explanation of this anomalous profile is a service town of mainly government and council workers supporting several nearby Aboriginal communities.
- It was assumed workers would be either FIFO or bussed from nearby communities with no implications for housing, a picture that becomes more dynamic with suggestions people may return home for work, straining already overcrowded housing. A young man aspires to come home and invest his wages in a house. But land in his Aboriginal community is communally owned and there are no spare blocks in town for him or anyone maybe wanting to start a business (a community development aspiration supported by the mining company).
- While the company aspires to the social justice objective of employing Aboriginal people, feedback suggests the mine may poach good workers from existing jobs rather than moving them from unemployment queues. To provide a realistic analysis of this fraught topic, one needs to heed the literature and lessons from other projects about how to move disadvantaged, long-term unemployed into meaningful work and different worldviews of whether we are defined by a 'job' or our relatedness to community and all the competing obligations this brings (McRae-Williams & Gerritsen, 2010).
- Five-year old Census data on the regional centre of Alice Springs (ABS, 2011) suggests an emerging trend of in-migration of residents born in India, Africa and the Philippines (Yuhun, Taylor, & Winter, 2012). By 2015, local knowledge suggests immigrant residents may comprise one-sixth of the town's population, with implications for recruiting workers and community composition and cohesion.

	Quantitative	Qualitative
Key features	Counting, data, modelling Presenting facts Desk research	Listening, insights, narrative Understanding community issues Fieldwork
Best use	Technical and operational decisions	People studies
Informs	Regulatory approvals Baseline data	Social performance Wise decisions
Culture, values	Rational, scientific, technical expertise, facts, certainty	Respect, diversity, subsidiarity, openness and accountability, distributive and social justice, human rights
Professional	Technical expertise, linear, inductive reasoning, order and logic.	Non-hierarchical and dynamic, capturing emerging issues.
Purpose	Regulatory approvals Scoping	Deeper insights to guide social performance
Spatial	Project footprint	Areas of social influence
Temporal	Point in time Starts at impact assessment phase	From project inception to closure Ongoing.
Advantages	Efficient	Effective
Disadvantages	Doesn't give the community a voice Misses the unknowns	May be expensive and 'over the top'
Tools	Models, tests, surveys	Participatory, literature reviews, case studies
Risk	ISO risk assessment: risk to project	Issues analysis: risk to community
Communication	Facts and figures (GDP, jobs, ML)	Emotional, values-based
Who commissions	Proponents	Proponents Governments (strategic assessment)
Who assesses	Regulators Management: early warning of risk	Regulators The community
When to use	Projects are straight forward	Issues are complex and emotive.

Figure 3: **Key features of quantitative and qualitative approaches to impact studies ****

Conclusion

The implications of this initial study include whether meaningful social impact assessment is possible when used just as a regulatory tool owned by more technically-focussed professions rather than as a multi-disciplinary approach that informs both regulatory approvals and long-term social performance by companies. What is valued by regulators is what will be rewarded when companies allocate funding to studies.

Regulatory approaches may be efficient (streamlined studies and approvals to meet the cost and time pressures) but not effective (gathering insights that guide good policy, practice and decision-making and reducing mistakes and conflict).

The discrepancies between approaches extend to communication about projects. Rather than a 'facts and figures' approach, communication that supports qualitative approaches needs to build understanding, reflect community values and address the issues that matter, not just those that can be counted.

Jane Munday

Jane Munday is a community engagement and social impact practitioner living in the Northern Territory of Australia, a large but sparsely populated land where one-third of the residents are Aboriginal (or First Nations). There are growing land use pressures and debate about issues such as water use, mining and fracking. Jane has experience in senior government communication positions. For 12 years ran her own business specialising in communication and community engagement. She has qualifications in Journalism, Psychology, Business Management, Community Engagement (public participation) and Social Impact Assessment. She is enrolled as a PhD student with the Northern Institute of Charles Darwin University on the subject of 'Qualitative approaches to social impact assessment'. This paper is an initial analysis to inform the focus of her study, so any feedback would be welcome to jane@janemunday.com.au

Bibliography

Arnstein, S. (1969). A Ladder of Citizen Participation. *Journal of the American Institute of Planners, 35*(4), 216-224.

Austin-Broos, D. (2009). Arrernte Present Arrernte Past. Chicago: University of Chicago.

Australian Bureau of Statistics. (2011). *2011 Census QuickStats: Alice Springs.* Retrieved May 18, 2015, from Australian Bureau of Statistics Census Data:

Baines, J., & Taylor, C. (2011). Ethical issues and dilemmas. In F. Vanclay, & A. Esteves, *New Directions in Social Impact Assessment* (pp. 96-113). Cheltenham: Edward Elgar Publishing.

Chambers, S. (2003, June). Deliberative Democractic Theory. *Annual Review of Political Science, 6*, 307-326.

Charlton, A., & Harris, L. (2016). A pox on both your houses: The rise of populism in Australia. *The Monthly*, 36-42.

Harvey, B. (2011). Foreword: SIA from a resource developer's perspective. In F. Vanclay, & A. Esteves, *New Directions in Social Impact Assessment* (pp. xxvii-xxxiii). Cheltenham: Edward Elgar Publishing .

Hoggan, J. (2016). *I'm Right and You're an Idiot: The toxic state of public discourse and how to clean it up.* Vancouver: New Society Publishers.

Howitt, R. (2012). Theoretical Foundations, in F. Vanclay, & A. Esteves, New Directions in Social Impact Assessment. Cheltenham: Edward Elgar Publishing .

International Association for Public Participation (IAP2) at www.iap2.org.au

Leighninger, M. (2016, October). The Economic Argument for Engagement: New Directions for Research. *Journal of Public Deliberation, 12*(2).

McRae-Williams, E., & Gerritsen, R. (2010). Mutual Incomprehension: The Cross Cultural Domain of Work in a Remote Australian Aboriginal Community. *The International Indigenous Policy Journal, 1*(2).

Mitchell, R., & Leach, B. (2015). Knowledge Integration in Impact Assessment: A Case Example from Panama. *IAIA Conference paper.*

Moffat, K., & Zhang, A. (2014). The paths to social licence to operate: An integrative model explaining community acceptance of mining. *Resources Policy, 39*, 61-70.

Parkin, J., & Mitchell, R. (2005). Public Participation as Public Debate: A Deliberative turn in Natural Resource Management. *Society and Natural Resources, 18*, 529-540.

Preston, B. (2014, October 22). *The adequacy of the law in satisfying society's expectations for major projects.*

Stevenson, M. (1996). Indigenous Knowledge in Environmental Assessment. *Artic, 49*(d), 278-291.

Surowiecki, J. (2005). The Wisdom of Crowds, Anchor Books, New York.

Vanclay, F. (2003, March). International Principles for Social Impact Assessment. Impact *Assessment and Project Appraisal, 21*(1), 5-11.

Vanclay, F., & Esteves, A. (2011). Current issues and trends in social impact assessment. In F. Vanclay & A. Esteves, *New Directions in Social Impact Assessment* (pp. 3-19). Cheltenham: Edward Elgar Publishing.

Vanclay, F., Esteves, A., Aucamp, I., & Franks, D. (2015). *Social Impact Assessment: Guidance for assessing and managing the social impacts of projects.* International Association for Impact Assessment.

Yuhun, P., Taylor, A., & Winter, J. (2012). *Alice According to You; A snapshot from the 2011 Census.* Darwin: The Northern Institute, Charles Darwin University.

Greenhouse Gases in EIA: Recommendations from Recent Experiences

Michael C. Murphy, Julia Kun, Sandra Banholzer, Sana Talebi
Stantec Consulting Ltd.

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There is still little guidance available in regulatory regimes or the general literature on how to assess releases of greenhouse gases (GHGs) and effects on climate change from a project. In present practice, a valued component is established as one of climate, a change in GHGs, or simply greenhouse gases, and the project-environment interaction is considered on this basis. In Canada, the federal requirements are to identify mitigation measures, quantify GHGs, and compare those to the industrial sector, the province, country and global totals. The guidance states that "contribution of an individual project to climate change cannot be measured", leading practitioners or regulators to sometimes interpret that determination of significance is not needed. This view is challenged on the basis of recent experiences with regulators, public, and legal community. In this update to an earlier paper (Murphy et al 2013), new ideas on boundaries and significance are presented.

Introduction

The scientific evidence that human activities are contributing to global warming and causing climate change is strong and continuing to mount. According to the IPCC, "anthropogenic greenhouse gas emissions are *extremely likely* to have been the dominant cause of the observed warming since the mid-20th century" (IPCC 2015). We conclude that those releases of GHGs have caused a significant adverse environmental effect on the climate. It is therefore essential to consider climate change and GHGs in environmental impact assessment (EIA). In this paper, we present some recent experiences and provide some recommendations on how best to do this.

Synthesis of Available Guidance

In a review to assess the status of incorporating climate change impacts in EIAs, both in developed and developing countries, it was concluded that EIA is an important decision-making tool, and is now a legal requirement in many countries. Further, while many documents describe the intent to incorporate GHGs and climate change into EIA, only two countries (Canada and Australia) have consistently considered these in their assessment process (Agrawala et al 2012). More recently, the consideration of climate change in EIA will be mandatory in Europe with the implementation of the EU EIA Directive from 2014.

In 2013, Spain approved laws to guide consideration of climate change in EIA. In the summary paper, a review of how climate change was considered in Spain included looking at 1500 records of decision. About 14% of these contained references to climate change. Many others offered citations only (Enríquez-de-Salamanca et al 2016).

A review of 10 transport developments in England suggested that effects of climate change were well explained; details on mitigation were lacking. This could be improved by *"…the production of guidelines, change of behaviour of EIA practitioners, more holistic consideration of climate change issues, rigorous post-decision monitoring and use of climate change terminology*" (Hands and Hudson 2016).

In a review of 19 EIA reports on renewable energy in Denmark, climate change and mitigation were included in almost all of them and there was an emphasis on the positive impacts (Larsen 2014).

In the United States, the Council on Environmental Quality (CEQ) published guidance on considering the effects of climate change. The CEQ advises federal agencies on reducing GHGs to use a scoping process to set reasonable spatial and temporal boundaries, and consider these in terms of impacts and sustainability, and refer to a threshold of 25 kilotonnes per year (kt/y) for projects to be assessed (Sutley 2010). In a review of policies from 6 areas in the USA, 3 key challenges were identified: addressing uncertainty, establishing significance, and addressing cumulative effects (Slotterback 2011). In California, an annual threshold of 7 kt of CO_2e is proposed using a 10 million Btu/hr boiler fired with natural gas as a benchmark. (CARB, 2008). These approaches may change.

The assessment of GHGs in EIA came to the forefront in Canada in 2007 with the filing of an EIA for an oil sands project in northern Alberta. The Kearl Project was assessed by a joint review panel of Alberta and Canada. Emissions would make up about 1.7% of the Alberta emissions. Yet, the panel concluded effects were not significant. The federal court appealed, stating the panel had erred, and requested justification for the use of regulatory thresholds, in this case emission intensities. Once provided, Canada approved the project (Chalifour 2008). It is common in Canada to assess GHG emissions and provide mitigation in EIAs, following the methodology prescribed by the Canadian Environmental Assessment Agency (CEAA 2003). Still, a clear definition of significance is often not provided (Ohsawa et al 2014). An update by the federal regulatory agency is anticipated.

It is evident that there is considerable variation in assessing climate change and GHGs in EIAs around the world.

On Thresholds of GHG Emissions

There were few statements found in the literature on thresholds related to assessment of GHGs in EIA. There is mention of low, medium, and high in guidance from Canada; however, these terms are not defined. Canada directed the provinces to implement a carbon pricing scheme by 2018. Most but not all provinces agreed. The transition is now in progress. Some thresholds for reporting and verification of GHGs have changed. These are important for consideration of significance.

A summary of recent targets, approaches, thresholds and pricing is shown in Table 1 (Lee-Andersen 2017).

Table 1. Survey of GHG Targets and Thresholds Across Canada

Jurisdiction	**Emission Targets**	**Approach - assess GHGs in EIA**	**Thresholds** Reporting + Verification (kt)	**Carbon Pricing** ($/tonne)
Canada	30% below 2005 levels by 2030	CEAA (2003)	Report - 50 changing to 10?	$10 - 2018 $50 – 2022

British Columbia	80% below 2007 levels by 2050; LNG – 0.16 tonnes/tonne LNG	CEAA (2003), provincial guidelines (PG)	Report – 10 Verify - 25	$30 – 2016
Alberta	Methane reductions from oil and gas by 45%, by 2025	CEAA (2003), PG	Report – 50 Verify - 50	$20 – 2017 $30 - 2018
Ontario	37% below 1990 levels by 2030;	CEAA (2003); PG, draft guideline to address climate change in EIA	Report – 10 Verify – 25 Cap and trade - 25	$20 – 2018 $75 - ?
Quebec	20% below 1990 levels by 2020; 37.5% below 1990 levels by 2030	CEAA (2003), PG	Report – 10 Verify - 25	2015 vintage allowances: $16.39
New Brunswick	35% below 1990 levels by 2030	CEAA (2003), PG	Report – 10 Management - 25	Putting a plan in place

Experiences with GHGs in EIA

Our team has conducted several EIAs over the past 25 years. The need to assess the potential effects of the project on climate change has changed during that time. In our experience, a proponent will always do what is required by law to meet regulatory requirements. When those are not clear, this is more difficult. Some experiences illustrate these uncertainties and difficulties.

In two mining EIAs in North America, the valued component was "atmospheric environment" and the assessment involved estimating project GHGs, considering magnitude, intensity, and duration. Thresholds of low, medium and high were: 50 kt/y and 500 kt/y in one and 100 kt/y and 1,000 kt/y in the other. Both residual and cumulative environmental effects were rated not significant. After review, the Agency found *"…is not likely to result in significant adverse environmental effects*".

In two EIAs for hydroelectric facilities in North America, the valued component was "atmospheric environment" in one, "GHG emissions" in the other. In both, the boundaries for assessment of the source emissions considered the watershed feeding into the water storage reservoir of the hydro dam. Significance was assessed by considering the low, medium, high thresholds in CEAA (2003). In both EIAs, clear statements were made regarding significance using those thresholds. The environmental effects of the Project on its own were rated not significant. The cumulative effects of one were rated not significant, and the other were rated significant. In that case, the Governor in Council decided that the significant adverse environmental effects are justified in the circumstances.

In recent EIAs for large refineries, the regulatory requirements for EIA were different. In North America, there were requirements to quantify GHGs from "well to wheel" in order to consider every possible aspect

of emission sources, mitigation, and sequestration. For refineries in the Middle East, the GHG emissions were quantified, with a full set of mitigation measures. In these instances, total emissions, excluding embodied emissions, ranged from 5 - 8 million t/y. Thresholds of 100 kt/y and 1,000 kt /y were used to distinguish medium and high releases. Effects were rated not significant.

In a large transmission line project in Eastern Canada, an EIA was conducted to satisfy both joint federal-provincial requirements. In the assessment, no substantive interactions between the project and atmospheric environment were anticipated, resulting in essentially no consideration in the EIA. The Project was approved and is currently undergoing construction. The upstream GHGs were not assessed.

For liquefied natural gas (LNG) projects in Western Canada, the valued component was "GHGs". Significance was assessed by considering the impact of project emissions on provincial and national inventory reports, by including CEA Agency guidance, by interpreting previous provincial decisions on like projects, and by comparing the project to an industry profile. Clear statements were made - the project's GHGs were rated significant on its own as well as cumulatively. The province stated that the magnitude of the emissions is significant in relation to BC's reduction targets - one of the first statements by a regulatory authority declaring significant effects related to GHGs.

Recently, the CEA Agency issued additional requirements to assess "upstream" emissions' (Canada Gazette 2016). Those are emissions associated with industrial activities from the point of resource extraction to the project under review. In scoping any project for EIA, it is clear to us as practitioners that the sources of GHGs to be assessed should only be those producing GHGs directly as a result of the project activities. For a linear facility such as a pipeline, or transmission line, the boundary for assessing and quantifying GHGs should be the start and finish of the proposed infrastructure, not including upstream or downstream – unless those activities are part of the project definition.

Discussions about significance directly between practitioner(s) and legal representatives revealed that the desire of the legal community is to declare there is "no significant adverse environmental effect" for GHGs. This is conflicting for a practitioner as guidance suggests that for a single project on its own this "cannot be measured", and cumulatively the effect of the project in combination with all other sources of GHGs is significant.

The way forward – practical guidance

Firstly, boundaries. It is essential to scope the source of GHG emissions in a way that reflects the activities associated with the project definition. This means carefully considering the direct and indirect sources of emissions and assessing the direct emissions. Secondly, significance. Regarding climate change and the release of GHGs to the atmosphere, it is clear that a significant adverse environmental effect on natural climate change exists now, for a project located anywhere on the globe. This is a direct result of the many human activities releasing GHGs to the atmosphere – it is the ultimate cumulative effect. Yet any one source is so small, that its effect is very difficult to detect.

Therefore, from a science perspective, we say that in any project, the environmental effects of the project on its own are rated not significant, and if greater than some practical value, the environmental effects acting cumulatively are rated as significant. This is better than stating the magnitudes are a small fraction

of global emissions and are therefore not significant. In light of the magnitudes and thresholds described above, the threshold values delineating low, medium, and high are recommended to be 25 kt/y, and 1,000 kt/y.

Conclusions

There is still considerable variation in assessing climate change and GHGs in EIAs around the world. Practical guidance is proposed here on how to address GHGs and climate change in EIA on the basis of the literature review, discussions with practitioners, and experience on several types of industrial projects. Boundaries and thresholds are proposed for assessment and significance in EIA.

References

Agrawala, S., Kramer, A.M., Prudent-Richard, P., Sainsbury, M., and Schreitter, V. 2012. Incorporating climate change impacts and adaptation into environmental impact assessments: opportunities and challenges, Climate and Development, vol. 4, no.1, January 2012, pp 26-39.

California Air Resources Board. 2008. Preliminary Draft Proposal - Recommended Approaches for Setting Interim Significance Thresholds for Greenhouse Gases under the California Environmental Quality Act, October 24, 2008.

Canada Gazette. 2016. Vol 150, No. 12. Available online: http://www.gazette.gc.ca/rp-pr/p1/2016/2016-03-19/html/index-eng.php.

Canadian Environmental Assessment Agency. 2003. Incorporating climate change considerations in environmental assessment: general guidance for practitioners. (Ottawa: The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, 2003).

Chalifour, N. A. 2009. (Pre)Cautionary Tale About the Kearl Oil Sands Decision - the Significance of Pembina Institute for Appropriate Development, et al. v. Canada (Attorney-General) for the Future of Environmental Assessment.

Cherubini, F., Fuglestvedt, J, Gasser, T, Reisinger, A. Cavalett, O, Huijbregts, M. Johansson, D. Jørgensen, S., Raugei, M., Schivley, G. Strømman, A H., Tanaka, K. and A. Levasseur. 2016. Bridging the gap between impact assessment methods and climate science. Environmental Science & Policy. Oct 2016, Vol. 64, p129-140. 12p.

Enríquez-de-Salamanca, Á; Martín-Aranda, R., and R. Díaz-Sierra. 2016. Consideration of climate change on EIA in Spain. Environmental Impact Assessment Review. Feb 2016, Vol. 57, p31-39. 9p.

Hands, S. and M. Hudson. 2016. Incorporating climate change mitigation and adaptation into EIA: a review of current practice within transport projects in England. Impact Assessment & Project Appraisal. Dec2016, Vol. 34 Issue 4, p330-345. 16p.

Intergovernmental Panel on Climate Change, IPCC. 2015. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel

on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Larsen, S V. 2014. Is EIA fulfilling its potential? The case of climate change in renewable energy projects. Impact Assessment & Project Appraisal. 2014, Vol. 32 Issue 3, p234-240.

Lee-Andersen S. 2017. Climate change essentials: navigating carbon pricing mechanisms. McCarthy Tetrault LLP. January 2017.

Murphy M., and K. Gillam. 2013. Greenhouse Gases and Climate in EIA – Practical Guidance. presented at International Association of Impact Assessment (IAIA) Annual Conference, Calgary, Canada, 2013.

Ohsawa, T. and P. Duinker. 2014. Climate-change mitigation in Canadian environmental impact assessments. Impact Assessment & Project Appraisal. 2014, Vol. 32 Issue 3, p222-233. 12p

Slotterback, C.S. 2011. 'Addressing climate change in state and local environmental impact analysis', J Env Planning + Management, vol. 54, no. 6, pp 749-767, July 2011.

Sok, V., Boruff, B.J., and A. Morrison-Saunders. 2011. 'Professional practice: Addressing climate change through EIA: international perspectives from a survey of IAIA members', Impact Assessment and Project Appraisal, 29 (4), Dec 2011, pp 317-326.

Sutley, N.H. 2010. 'Draft NEPA guidance on consideration of climate change and GHGs', Memorandum for Heads of Federal Departments and Agencies, Council of Environmental Quality, Office of President of USA, pp 1-12, Feb 18, 2010.

Method to Assess Climate Change Risks in Buildings

Andrew H Murray[1]

Abstract - *In response to a business demand for a simple risk assessment method for assessing potential climate change and sustainability risks in existing commercial properties, a bespoke assessment method was created. The process is described within the paper.*

Following a literature review and evaluation of existing property assessment methodologies, an excel based assessment and reporting tool was created with a set of 12 risk criteria, each with multiple bespoke sub-issues, resulting in 67 no. issues in total. A scoring system was developed where Net Risk value is calculated as the Gross Risk modified by the effectiveness of any current Control Measures, with Gross Risk calculated as: the likelihood of exposure to a risk multiplied by the potential impact (both scored on a 1-5 scale), thus providing a quantifiable Net Risk score.

The results of the risk assessment and built in recommended mitigation measures are used to advise on a mitigation programme with the aim to: improve resilience, lower potential future risk and guide financial decision making within existing properties.

Key words – Buildings, Assessment methodology, Sustainability, Property, Risk model, Mitigation

Introduction

A changing global climate poses multiple and significant risks to existing property portfolios (1). This paper describes a bespoke assessment methodology that was developed to quantify potential risks and provide recommended mitigation measures for existing commercial property, principally UK-focused but globally applicable.

When considering commercial property decisions, timeframes are often multi-decadal. Therefore investors, owners and occupiers are increasingly expecting new construction projects to consider potential future risks related to sustainability and climate (2). Long term sustainability considerations are also a consideration at a national level, reflected in minimum building standards and planning regulations. Furthermore, construction assessment methods, such as LEED, BREEAM, SKA and WELL, are increasingly being applied (3), either voluntarily or as a legislative planning requirement, providing a quantifiable measure of building performance for newly constructed or refurbished assets.

It has been noted that in Europe and North America few standardised methodologies exist for assessing risk in existing properties (4). Operators in the commercial property sector recognised a market demand for a simple assessment method that is less onerous than extensive formal assessment, yet provides insight into risk exposure and guide potential mitigation for existing properties.

In response, a straightforward assessment methodology was developed to: quantify the likelihood and impact of potential climate change and sustainability risks; assess current mitigation measures and produce a net risk value for a number of key issues. Targeted at guiding early intervention, the information produced is also of benefit for financial considerations, investments, insurance considerations and negotiating lease agreements.

An easy to use Excel-based assessment and reporting method was designed for use by Building/Facility Managers (FM), or similar professionals, to undertake the assessment process, with guidance from appropriate expertise where necessary. This paper will describe the process undertaken in creating the assessment, the outputs and the lessons learned.

Methodical Approach

Assessment Scope

[1] Andrew Murray is a consultant for Ramboll Environ specialising in assessment and sustainable solutions
Address - Ramboll Environ, Artillery House, 11-19 Artillery Row, London, SW1P 1RT, UK
Tel - +44 20 7808 1473
Email - amurray@ramboll.com

The initial scope was to identify building performance at multiple individual commercial office properties against a set of predetermined risk criteria, in order to quantify the likelihood and impact of the potential risk, including any mitigation present. This would be achieved by generating an output which identifies potential risks to the property and/or business operations with potential to negatively affect performance, then support measures to reduce risk.

Research and Literature review

A literature review of sustainable construction methodologies, climate change risks and building management resources was undertaken, focusing on existing UK/US/EU regional and national built environment risk assessments and property climate change and sustainability assessment formats (5) (6). A bespoke list of risk assessment issues were created based on the reoccurring themes within the literature review.

Climate change and sustainability risks are both global and interconnected. Therefore, simple consideration of local physical weather changes, although often a significant factor, may lead to not considering the localised environmental and social impacts as a consequence of climate change effects on wider regional and international scales. For example, it is expected that by 2050 there will be between 200 million to 1 billion climate refugees globally (7); causing potential direct and indirect impacts on the property/organisation being assessed through changes in social dynamics, political environment and wealth distribution, thus creating potential risks worthy of consideration.

Identification of Key Risk Issues

A comprehensive set of risk factors were determined based upon 12 Risk Criteria, with a number of regional bespoke sub-issues for each, see Table 1.

Table 1: List of risk assessment issues, description and number of sub-issues

Issue	Description	No. sub-issues assessed
Energy Efficiency	Risk of higher fuel costs, energy security issues, associated negative environmental externalities.	6
Water Efficiency	Increasing demands on water, changes in precipitation patterns and additional environmental protection legislation may lead to reduced availability (with potential restrictions on use), higher water costs and greater environmental impact from extraction and waste water treatment.	7
GHG Emissions	Associated extraneous impacts from emissions; likely increases in legislative controls, reporting requirements and stricter emission requirements; impact from reputational expectations and damages; greater consideration of GHG emissions when accessing finance and valuation of an asset.	5
Building Safety & Materials	Structural integrity of asset, potential for increased maintenance costs, loss of business continuity and income from major disruptions, potential for whole building to be unsuitable for occupation.	7
Transportation	Increasing fuel costs, pollution emission controls and congestion could affect ability of staff and products to get to and from the asset.	6
Contamination	Site and building has potential to cause environmental damage or effect human health, with associated business liabilities and potential risks of legislative and financial implications if site causes negative environmental/human health effects.	4
Natural Hazards	Direct risk of natural hazards impacting on the asset and its operation; risk of increasing difficulty in obtaining finance, greater insurance costs, lower rental income potential, disruption to business continuity.	4

Climate Change	Unknown consequences of changing climate on asset physical structure, access to resources, impact on business operations. Greater legislative and reporting requirements with financial and legal consequences.	6
Socio-economic	Assets and organisations operate within the wider social and economic environment, both influencing and being influenced by it. The socio-economic environment can offer potential opportunities and risks.	9
Regulatory	Risk from legal impacts, reputational losses, additional charges, costs and fines.	3
H&S and Wellbeing	Risks of legislative non-compliance, lower rates of productivity, asset value and exposure to litigation.	9
Other	Risk of changing pattern of engagement from internal stakeholders.	1

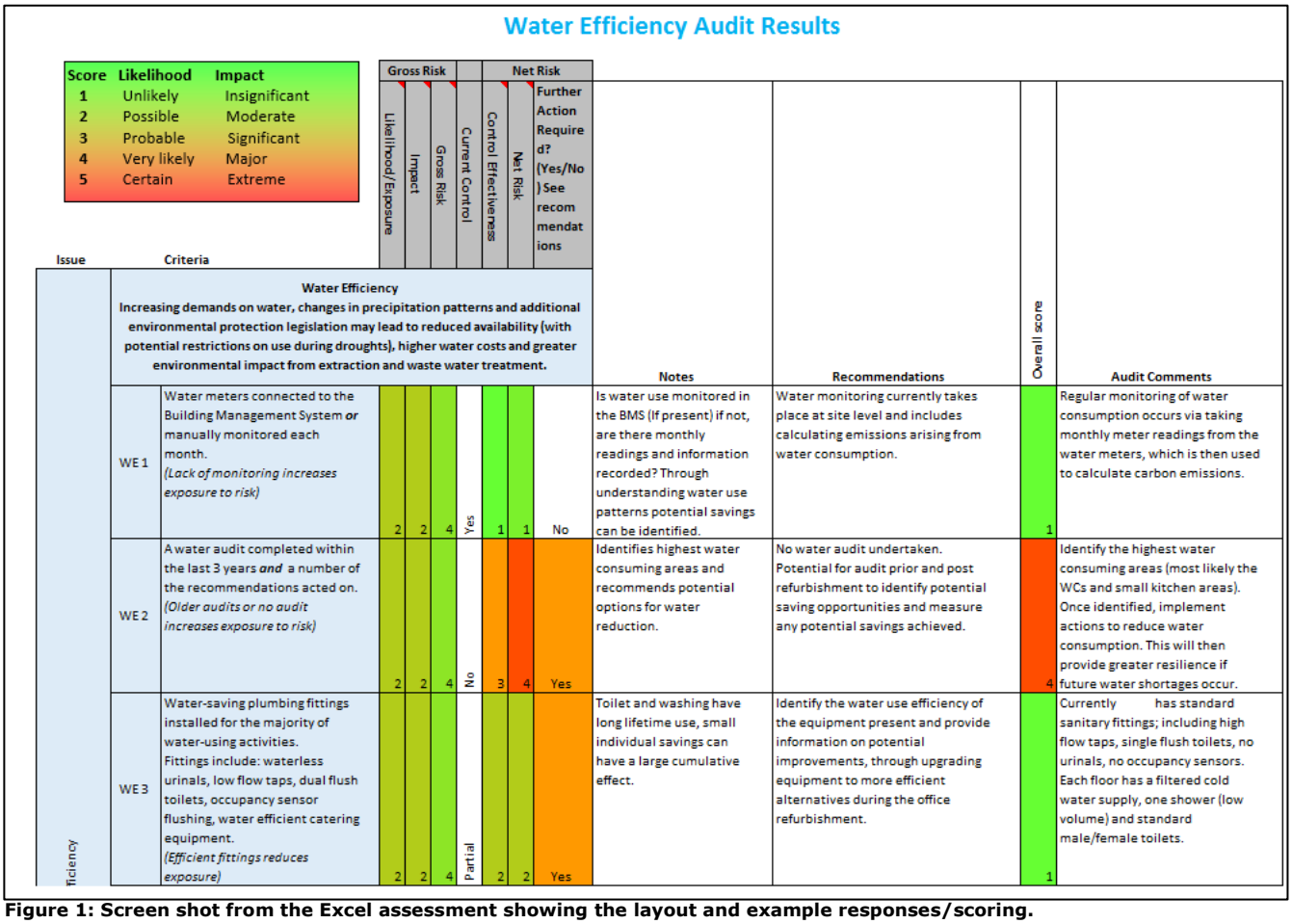
Creation of Assessment Methodology

An Excel workbook was created for each property assessment. Each workbook has the following sections:

- Introduction text – brief outline of the assessment; site information; audit details, purpose and approach.
- Results summary – Gross Risk, Net Risk and Normalised Risk output for each assessment issue with recommendations;
- Assessment issues overview – description of each Risk Criteria;
- Method – description of key terms, assessment instructions, recommended reading prior to an assessment and guidance;
- Individual assessment and scores – each assessment issue has a specific assessment tab (see Figure 1 for an example);
- Graphs – visual representation summary of the risk assessment scores including Gross and Net risk; and
- Data tab – optional input tab to store assessment data, such as energy use, water use and other quantifiable metrics for reference.

The layout, scale and size of the Excel workbook was designed to be outputted as a standard A4 (US 'letter' paper size) report style format, PDF and printer compatible, with the intention to be easily included in building information records, corporate reporting or due diligence portfolios.

An example of the layout for each assessment issue can be seen in Figure 1. Following feedback, the current iteration has a single assessment reporting and scoring sheet. This was found to be the most effective way to engage relevant stakeholders, as the logic behind the issue, scoring and the proposed mitigation can easily be followed through, creating greater 'buy in' for intervention.



Water Efficiency Audit Results

Score	Likelihood	Impact
1	Unlikely	Insignificant
2	Possible	Moderate
3	Probable	Significant
4	Very likely	Major
5	Certain	Extreme

Issue	Criteria		Gross Risk: Likelihood/Exposure	Gross Risk: Impact	Gross Risk: Gross Risk	Current Control	Net Risk: Control Effectiveness	Net Risk: Net Risk	Further Action Required? (Yes/No) See recommendations	Notes	Recommendations	Overall score	Audit Comments
ficiency	Water Efficiency Increasing demands on water, changes in precipitation patterns and additional environmental protection legislation may lead to reduced availability (with potential restrictions on use during droughts), higher water costs and greater environmental impact from extraction and waste water treatment.												
	WE 1	Water meters connected to the Building Management System *or* manually monitored each month. *(Lack of monitoring increases exposure to risk)*	2	2	4	Yes	1	1	No	Is water use monitored in the BMS (If present) if not, are there monthly readings and information recorded? Through understanding water use patterns potential savings can be identified.	Water monitoring currently takes place at site level and includes calculating emissions arising from water consumption.	1	Regular monitoring of water consumption occurs via taking monthly meter readings from the water meters, which is then used to calculate carbon emissions.
	WE 2	A water audit completed within the last 3 years *and* a number of the recommendations acted on. *(Older audits or no audit increases exposure to risk)*	2	2	4	No	3	4	Yes	Identifies highest water consuming areas and recommends potential options for water reduction.	No water audit undertaken. Potential for audit prior and post refurbishment to identify potential saving opportunities and measure any potential savings achieved.	4	Identify the highest water consuming areas (most likely the WCs and small kitchen areas). Once identified, implement actions to reduce water consumption. This will then provide greater resilience if future water shortages occur.
	WE 3	Water-saving plumbing fittings installed for the majority of water-using activities. Fittings include: waterless urinals, low flow taps, dual flush toilets, occupancy sensor flushing, water efficient catering equipment. *(Efficient fittings reduces exposure)*	2	2	4	Partial	2	2	Yes	Toilet and washing have long lifetime use, small individual savings can have a large cumulative effect.	Identify the water use efficiency of the equipment present and provide information on potential improvements, through upgrading equipment to more efficient alternatives during the office refurbishment.	1	Currently has standard sanitary fittings; including high flow taps, single flush toilets, no urinals, no occupancy sensors. Each floor has a filtered cold water supply, one shower (low volume) and standard male/female toilets.

Figure 1: Screen shot from the Excel assessment showing the layout and example responses/scoring.

Scoring Methodology

Each Risk Criteria is made up of multiple sub-issues which address a specific concern, risk or best practice. Each of the sub-issues has: an evidence criteria, description notes explaining the risk posed and suggested recommended mitigation actions.

For each applicable sub-issue, the level of risk (Net risk) is determined using the following standard approach.

Equation 1:

$$\text{Net Risk} = \frac{\text{Gross Risk } (\textit{likelihood} \times \textit{impact})}{\text{Current control effectiveness}}$$

Where:

Gross Risk is the sum of the likelihood score and the impact factors, which are defined as:

- Likelihood/Exposure: how likely the risk is to occur or how exposed the building/organisation is perceived to be. Scored on a scale from 1-5 (unlikely, possible, probable, very likely, certain).
- Impact - the potential magnitude of impact the issue may have on the building/organisation if the sub-issue occurred. Scored on a scale of 1 to 5 (insignificant, moderate, significant, major, extreme).

Current Control - if there is currently a control mechanism in place which is deemed to reduce the exposure or impact of the risk. Scored as: Full, Partial, or No control.

Net Risk – the Gross risk modified by the level of Current Control effectiveness - if there is a complete (full) control mechanism in place ('Yes' in control box) the risk is deemed to be controlled (thus removing the risk to a minimum score of 1); 'Partial' control is where there is a control in place but it is deemed to only partially control the issue (halves the Gross Risk score); 'No' control is deemed that there are no effective controls currently in place, or those present are deemed to offer an inadequate level of control, (no impact on the Gross Risk score).

Normalised Risk - displayed in results tab, identifies a specific key risk issue which is deemed to be of much higher risk than the others, therefore should be a focus of further work, mitigation or assessment. Calculated as the issue's total Net Risk / count of sub-issue categories.

Assessment Process

Once the specific risk sub-issues have been finalised for the site, information is requested for the relevant evidence prior to undertaking a site audit. Evidence viewed should be verified and recorded within the assessment tool for reference and provide an audit trail. It is important that evidence is retained and stored appropriately, depending on appropriate business sensitivity. This allows for follow up assessments or use as evidence in other assessment or reporting frameworks. Site audits should be carried out or supervised by sufficiently qualified individuals; accurately recorded; and used as a verification exercise, assessing specific sub-issues and discussing potential risks with appropriate stakeholders.

Once all issues have been satisfactorily audited and the results collated, recommendations for mitigation can be considered in line with industry best practice, guidance and expert opinion. When considering mitigation having input from key stakeholders is often important in creating realistic and achievable solutions, as well as achieving a greater success rate of buy in (8).

Learning points

Key learning points taken from the project include:

- Although intentionally designed to be simple and easy to use, the assessor needs to be suitably knowledgeable. It was found that greater value can be obtained from an experienced and/or qualified assessor;
- Using a 1-5 risk assessment scale and 3 levels of current control, maintains simplicity without too great a loss of specificity;
- Issues of subjectivity between individual assessors was found. There is a need for internal checks and controls to ensure consistency; and
- Assessment results are useful as an initial assessment of overall risk, further due diligence of individual findings are recommended prior to financial decisions.

The following advantages to undertaking a sustainability audit have been recorded from user feedback:

- Measure and improve business resilience to potential future risks;
- Increased investment assurance in long term viability;
- Improved occupier satisfaction and/or potential productivity of staff;
- Recognition in assessment frameworks, such as Global Real Estate Sustainability Benchmark (GRESB), European Public Real Estate Association (EPRA);
- Provide a competitive advantage;
- Lower financing costs, insurance premiums (financial institutions are beginning to offer favourable rates for buildings deemed as lower risk);
- Increase retail or lease value;
- Reputational advantage through promotion of sustainable behaviours;
- Stay ahead of potential new legislative changes, issues and corporate goals;
- Provide a focused approach to risk mitigation and intervention measures; and
- Track progress in risk reduction.

Conclusions

There is significant potential for improvement in the existing property sector through the use of relatively quick and easy assessments focusing on a broad range of sustainability and climate change related risks. Creation of bespoke risk assessment methodologies are achievable at an organisational level and offer significant business benefits.

Bibliography

1. *Climate Change: Implications for Buildings.* **Chalmers.** 2014, IPCC 5th Assessment report.
2. *Sustainable real estate investment Impmenting the Paris Climate Agreement: An action framework .* **P., Bosteels T. & Sweatman.** Climate & Strategy Partners.
3. *Global Investor Survey on Climate Change. Annual Report on Action and Progress 2010.* **IIGCC.** s.l. : Global Investor Coalition, 2010.
4. *Assessing the cliamte change adaptability of buildings.* **al, Malay D. et.** s.l. : NCCARF, 2012.
5. *Assessing Current Climate Risks.* **R., Jones. R and Boer.** s.l. : UNFCCC, 2015.
6. *Current knowledge on relevant methodologies and data requirements as well as lessons learned and gaps identified at different levels, in assessing the risk of loss and damage associated with the adverse effects of climate change.* **Surminski S., Lopez A,. Birkmann J., Welle T.** s.l. : UNFCCC, 2012.
7. *Crisis or adaptation? Migration and climate change in a context of high mobility.* **Tacoli.** s.l. : IIED, 2009.
8. *Stakeholder Involvement in Decision Making: A Short Guide to Issues, Approaches and Resources.* **OECD.** s.l. : OECD, 2015.

IMPACT ASSESSMENTS FOR A COAL MINING PROJECT IN TANZANIA: SHARING EXPERIENCE ON RESILIENCE AND ADPTATION TO CLIMATE CHANGE

Agnes E.G. Mwakaje
University of Dar es Salaam, Tanzania
amwakaje@udsm.ac.tz

Introduction

Tanzania is endowed with diverse energy sources including natural gas, hydropower, biomass, and coal deposits. Yet only 36% of the nearly 50 million Tanzanians are connected with electricity and only 11% in rural areas (URT, 2015). Still biomass dominates the energy sector by almost 88%. Other sources are electricity 3%, oil and gas 8%, coal, solar and wind 1% (ECS, 2015). For many years Tanzania has relied on hydropower electricity which currently provides over 65% of the electricity supply in the country. However, hydropower production has been significantly affected by prolonged droughts and unreliable rainfall. Annual power demand is expected to increase from the current consumption of 1,583 MW to at least 3,800 MW by 2025 (URT 2015).

The government has now put clean energy at the top priority of the development agenda. In June 2014, the government launched its 2014-2025 Electricity Supply Industry Reform Strategy and Roadmap, under which it aimed to increase electricity generation from the current of about 1,600 MW to about 11,000 MW in 10 years (Makoye, 2014) for both local consumption and export. Key to the strategy is the intensification of power generation from natural gas and coal. The government plans is to increase the connectivity level to 30%, 50% and 75% by 2015, 2025 and 2033, respectively (URT, 2015).

Despite the threat of climate change, Tanzania plans to produce two-thirds of the country's energy to come from coal and natural gas (Makoye 2014). Coal-based power is claimed to be scalable and have a relatively low capital although one of the anonymous reviewers (2017 argue that the capital cost is high compared to other sources of power with exception to nuclear. Another reason in favour of coal based energy is low remediation cost (Edenville Energy PLC, 2012). There is concern that increasing use of coal, could double the country's emissions of greenhouse gases (Makoye, 2014). In Tanzania, the impact of climate change is real, rivers are drying up, the country is experiencing unreliable and erratic rainfall patterns which has caused frequent droughts and affected agricultural productivity (Mongi *et al* 2010). Climate change has also increased crop diseases and pests and consequently necessitated changes in the farming systems whereby irrigation agriculture, invasion of wetlands and rivers and intensive use of agrochemicals are on increase. Also diseases such as malaria are on increase because of the raised temperatures (Wandiba *et al* 2010). All these have increased government expenditure and cost of living in.

However, while energy production projects have impact on climate change it is not clear whether there has been any good practices in the sector in Tanzania. This paper presents findings from a coal mining project with the focus of impacts on social, environmental and climate change. Mitigation measures and adaptation strategies are presented. The paper also shares experience on good practices on climate change resilience and adaptation.

The Coal Energy Development in Tanzania

Tanzania's coal reserve is estimated at 5 billion tons, with 25% being proven (World Coal, 2015; URT 2015). Production of bituminous coal rose significantly during 2010–2013, from 179 tons to 128,920 tons. Currently coal is exploited in small scale at Kiwira Coal Mine in Mbeya Region and Tancoal Energy Limited Mine at Ngaka in Ruvuma Region. At an estimated maximum production rate of 4-5 million tons per annum, the Ngaka Coal Project has sufficient proven coal resources for over 50 years of profitable, low-cost production (TC, 2016).

However, the highest coal deposits have been discovered in the area called Ketawaka-Mchuchuma in the Ruhuhu Basin. It is estimated that Mchuchuma coal deposits have more than 480 million tonnes of coal reserve. In September 2011, China's Sichuan Hongda Co. Ltd. signed a $3 billion deal with Tanzania government to mine coal and iron ore in a joint-venture with a local organisation to form "Tanzania-China International Mineral Resources" Ltd (TCIMR). This investment will involve construction of the Mchuchuma Coal Mine and an accompanying 600-megawatt (MW) thermal power station (TCIMR, 2014). The mined coal will be used for generation of coal-fired electricity at Mchuchuma and power the iron and steel works at Liganga as well as to increase the national grid electricity capacity (TCIMR, 2014).

Coal mining at Mchuchuma will originally involve *surface mining* which will be undertaken for 3 to 5 years with a capacity of 1.8 million tons/annum via open-cast technology. Coal will be fed into thermal power plant during the transition to underground mining with a capacity of 3.0 million tons/annum. Surface coal mining will be done via stripping system using heavy equipment and machines. Hole blasting will be used for non-coal material and hence the use of explosives technologies. Some of the coal will be used at Liganga for processing of iron ore and steel works. There will be also construction of roads and the project is likely to consume large quantity of water from Kitewaka and Ruhuhu Rivers during both construction and operation phases.

As part of the Tanzania legal fulfilment (EMA, 2004) the Environmental and Social impact Assessment (ESIA) was conducted in 2014. This study presents key findings that may affect climate change.

Results and Discussion

The proposed coal mining project will lead to influx of people at an estimated rate of 5000 into the project area seeking employment, food vending and some even conducting prostitution and robbery/violence behaviour (TCIMR, 2014). This will certainly increase the demand for food and increase prices. These changes are likely to stimulate more food production by invading virgin and forestry lands clearing for agriculture, fuelwood and charcoal production, turning deforestation into investment opportunity (Angelsen, 1999). But also open-cast mining technology is preceded by removal of all vegetation. Removal of vegetation will involve felling down of trees and other biodiversity including wildlife. In addition, the proposed coal mining project will use large quantity of fossil fuels for running machine, processing and transporting coal to other areas. Vegetation clearance will reduce forest ecological functions such as carbon sequestration and prevention of soil erosion, thus

impacting on climate change. In addition, large quantity use of fossil fuel by vehicles and machines has direct impact on climate change in terms of carbon dioxide emissions through mineralization and the reduction of biomass in soils due to vegetation clearance among others (Shrestha and Lal, 2006). Noise created during constructions and transport can affect wild animals which may disappear in the mining localities. The process of transporting material to and from the project area could lead to the introduction of alien species, spillage and dust production.

Mitigation measures shall include avoidance of interference with wildlife migratory routes, planting indigenous tree species and concentrating mining works in core areas. Also practice regular inspection of vehicles to make sure they do not contain alien species and provide education to workers and local communities on alien species. This shall be a responsibility of the coal mining company (the developer) under the supervision of the National Environmental Management Council (NEMC) and the Ministry of Natural Resource and Tourism (MNRT). They should also provide noise proof facilities and enforce thoroughly monitoring and reporting.

Mitigation measures on climate change shall include planting of trees under professional supervision and promote fuel efficient cooking stoves. The Developer shall also set up drainage pumping facilities, water storage, ditches, drainage pipes and drainage systems in the underground mining

Generally the Government shall promote private investment in renewable energy production especially from wind and solar production through conducive investment policies. Areas of high wind in Tanzania are estimated to be more than 10% of the country's land (URT, 2015). Tanzania has also high potential of solar energy estimated between 2,800-3,500 hours of sunshine per year (ADBG, 2015). Currently, the country total energy production from renewable resources is insignificant of only 4.9%.

Social impacts

As pointed out earlier, the proposed coal mining will lead to influx of people from different parts of the country and beyond. This has direct impact socially through a risk of diseases transmission e.g STD including HIV/AIDS and may also threaten local security (see for example Shandro *et al* 2011). Movement of machines and vehicles will create noise, accidents and dust which will affect human health and social infrastructure like roads, water bodies etc.

Such events will increase government expenditure in terms of disease prevention and treatments and provision of health facilities such as hospitals. The government has to provide and/or improve health services such as voluntary counselling and tests (VCT) facilities and health centres through the Ministry of Health. The government also needs to provide education on disease prevention from both local and the incoming population, in collaboration with the developer providing protective gears for diseases control. It may also demand more staff in the health sector by the Ministry of Health. Other mitigation measures come through the Ministry of Home Affairs by increasing number of police force.

It will also affect households' income expenditures in terms of treatment and security enhancement.

Coal mining is also regarded as a destructive activity in the sense that open cast technology creates polluting piles and toxic ash dumps, and threatens basic needs e.g drinking water, clean and fresh air (WSA 2017). Construction of access roads could lead to noise and dust production. These affect both the environment and human health and; directly impacts on social costs. Mitigation measures by the developer shall include proper management of waste including disposal in properly constructed landfill and incineration. Other mitigation measures include regular servicing of machines and vehicles, wetting of roads, putting signs for speed limit and proving noise proof facilities. The Ministry of Health is responsible for ensuring health mitigation measures are implemented as required.

Good practices to climate change resilience

Government has been facilitating access to loans for livelihood diversification in project areas e.g promotion of community banks; saving and credits cooperatives (SACCOS) which enables low income communities access credits with relatively low interest rates.

At policy level, Tanzania has enacted a number of policies and laws for addressing climate change issues and/or supporting initiatives for climate change management. These include environmental conservation and protection of forest lands in mining areas.

The Tanzania Five Year Development Plan (2012) strongly emphasizes mitigation, adaptation and creation of a financial framework to combat climate change. A National Climate Change Strategy has been formed to pinpoint, mobilise and oversee global climate funding and energy projects where investors are part of the strategy implementation.

The 2006 National Plan outlines risks related to climate change and strategies on environmental education, cooperation and monitoring across sectors and government agencies, central and local governments. The plan also provides guidelines for halting deforestation, desertification and promotion of diverse energy sources. However, the Plan lacks explicit mechanisms for inter-sectoral climate change programmes (GRI, 2015).

Tanzania also released a National Climate Change Strategy in 2012, to address both adaptation and mitigation in line with the country's vision for sustainable development.

The government has also established the National Environment Management Council (NEMC) under the Vice President's Office to oversee environmental management in the country including monitoring projects performance.

According to the Ministry of Energy and Minerals (MEM) Report (2014), there must be financial assistance to small-scale miners for promoting mining technology and value addition. The report also emphasizes on retaining at least 30% as minimum for female beneficiary. This is intended to promote women's economic participation in the mining sector

Linkages between Mining and the Local Economy have also been emphasized. The government through MEM (2014) promotes linkages between mining and the local

economy through (i) supporting local budgets where mines operates and mainstreaming mining activities into districts strategic plans.

Investors are responsible for providing corporate social responsibility for surrounding communities. In Mtwara Region for example, natural gas investors volunteered to vocational trainings for 150 youth. Such activities improve livelihoods and reduce pressure on natural resources such as tree felling for economic activities. Also all villages where natural gas is produced are provided with electricity at a high connection discount.

References

ADBG (2015): African Development Bank Group in Africa, Renewable Energy in Africa: Tanzania Country Profile.

Angelsen A (1999): Agricultural expansion and deforestation: modelling the impact of population, market forces and property rights. Journal of Development Economics. 58 (1), pp185–218

ECS (2015):Tanzania Energy Sector under the Universal Principles of the Energy Charter. Brucells July 2015.

GRI (2015): The Global Climate Change Legislation Tanzania: Granthom Research Institute of Climate Change and the Environment: http://www.lse.ac.uk/GranthamInstitute/legislation/countries/tanzania/

Makoye K (2014): Tanzania turns to more gas and coal to meet its energy needs. http://news.trust.org//item/20140723140401-5rq3c

MEM (2014): The Environmental and Social Management Framework and the Environmental and Social Assessment for the Sustainable Management of Mineral Resources Project (SMMRP) Phase II

Mongi H, Majule A.E, and Lyimo J.G. (2010): Vulnerability and adaptation of rain fed agriculture to climate change and variability in semi-arid Tanzania. African Journal of Environmental Science and Technology 4 (6).

Shandro' J.A; Veiga M.M; Shoveller J. Scoble M. Koehoorn M (2011): perspectives on community health issues and the mining boom–bust cycle. Resources Policy, 36 (2), pp 178–186.

Shrestha RK and Lal R (2006): Ecosystem carbon budgeting and soil carbon sequestration in reclaimed mine soil. Environment International 32 (6), 781-796

TC (2016): Tanzania Coal: http://www.tanzaniainvest.com/coal

URT (2016): Tanzania Has High Potential For Renewable Energy Projects, US Consulting Firm Indicates. http://www.tanzaniainvest.com/energy/tanzania-has-high-potential-for-renewable-energy-re-projects

TCIMR (2014): Environmental and Social Impact Assessment for the Proposed Coal Mining in Ketawaka-Mchuchuma in the Ruhuhu Basin. Tanzania-China International Mineral Resources, Unpublished.

URT (2015): Tanzania National Energy Policy, Government website.

Wandiga S.O; Opondo M; Olago D; Githeko A; Githui F., Marshall M., Downs T., Opere A., Oludhe C., Ouma G.O; Yanda P.Z., and Kangalawe R., (2010): Vulnerability to epidemic malaria in the highlands of Lake Victoria basin: the role of climate change/variability, hydrology and socio-economic factors. Climatic Change. Volume 99 (3), pp 473–497

WCA (2017): Coal mining & the environment. https://www.worldcoal.org/environmental-protection/coal-mining-environment

World Coal (2013): Tanzania revises up coal reserves. https://www.worldcoal.com/coal/09072013/tanzania_revises_up_coal_reserves_258/

Costs and GHGs impact of emerging oil sands technologies

Experience Nduagu*, Alpha Sow, Evar Umeozor, Dinara Millington
Canadian Energy Research Institute, 3512- 33 Street NW Suite 150, Calgary, T2L 2A6, Alberta, Canada.

ABSTRACT

The vast oil sands resources in Western Canada provide significant economic and societal benefits for Canada. However, the extraction and processing of oil sands is not only capital intensive but also results in high energy use and greenhouse gas (GHG) emissions impacts. Reduction of the associated production costs and GHG emissions impacts are two important challenges facing the oil sands industry. Consequently, numerous research and development (R&D) projects are being undertaken. However, what is missing from the research is an evaluation of environmental in conjunction with economic impacts of these R&D projects. This study bridges this gap through a detailed techno-environomic assessment of the potential of the emerging *in situ* technologies to reduce supply cost and GHG emissions in the short and long runs. Major technologies that could be commercially deployed in *in situ* process-based projects are covered. Results show that opportunities exist to significantly reduce costs and emissions using reservoir and steam generation technologies. The cumulative effect of some of the new technologies can achieve potential reduction of bitumen supply cost by 34-40 percent as well as reduce fuel-derived emissions from *in situ* oil sands production by 80 percent, and consequently delay the time until the emissions cap is reached. Findings in this study provide insights into the capability of emerging technologies to address the pressing cost and GHG emission challenges facing the Alberta oil sands industry.

*Corresponding author. Email: enduagu@ceri.ca

INTRODUCTION

The objective of this study is to explore how innovation and technology development efforts in the oil sands industry can lead to costs and emissions reduction in bitumen extraction and processing. We identify new technologies and processes that can be deployed in the oil sands industry within the next 5-7 years and how these options can reduce fuel-based emissions and supply costs. The supply cost of bitumen captures the minimum constant dollar price needed to recover all capital expenditures, operating costs, royalties and taxes and earn a specified return on investment.

This study focuses on *in situ* bitumen extraction and processing technologies because future of oil sands developments is expected to be predominantly *in situ*-based due to resource deposition characteristics in Alberta. This is because more than 70% of the recoverable bitumen is too deep to be mined. *In situ* bitumen extraction includes steam-assisted gravity drainage (SAGD) and cyclic steam stimulation (CSS) approaches. These *in situ* methods have similar characteristics as they involve injection of high pressure and high temperature steam into oil sands reservoirs to reduce bitumen viscosity, mobilize and recover bitumen. Once the product has been recovered at the surface, a central processing facility is used to purify the bitumen product prior to sales.

METHODS

A conventional SAGD facility with steam-oil ratio (SOR) of 3 m^3/m^3 and 30,000 barrels per day (bbl/day) production capacity is set as the baseline. SOR is the volume of steam (cubic meter cold water equivalents) injected into the reservoir to produce a cubic meter of bitumen. The SOR is used to measure the efficiency of an *in situ* bitumen extraction process – the lower the SOR, the more efficient the process is. The bitumen production and processing facilities are sub-divided into segments that constitute the oil sands process chain. These segments include Water and Waste Treatment (*WWT*), Steam Generation (*SG*), Wells and wellpads (*WWP*), Reservoirs (*RES*), and

Business Management and Data Analytics (*BM*). These technologies and processes are assessed to determine their potential contribution to reduction of supply costs and process fuel-derived GHG emissions in bitumen production and processing.

With various technologies identified and assessed for their cost and emissions reduction potential, six optimal technology paths (five for greenfield projects and one for brownfield), as shown in Table 1, were determined. These technology paths were constructed in a way that allows for a combination of complementary processes and technologies in the bitumen extraction and processing chain to be combined to reduce supply costs and GHG emissions. Detailed explanations of the technologies highlighted in Table 1 can be found in Nduagu et al. (2017).

Table 1. Optimal technology configurations for Brown- and Greenfield

<table>
<tr><th rowspan="2">Technology configurations</th><th colspan="5">Compatible processes and technologies</th></tr>
<tr><th>BM</th><th>WWP</th><th>RES</th><th>WWT</th><th>SG</th></tr>
<tr><td colspan="6">Brownfield development</td></tr>
<tr><td>Steam solvent</td><td></td><td>Steam flood management</td><td></td><td>Steam Solvent</td><td>Magox precipitation and CO_2 conversion</td><td>OTSG</td></tr>
<tr><td colspan="6">Greenfield development</td></tr>
<tr><td>Steam with CO_2 co-injection</td><td rowspan="5">Digitalization of EPC</td><td rowspan="5">Steam flood management</td><td rowspan="5">Wellpad standardization</td><td>Steam/CO_2 co-injection</td><td rowspan="2">Evaporator</td><td>DCSG</td></tr>
<tr><td>Steam with CoGen</td><td>Steam</td><td>SOFC</td></tr>
<tr><td>Steam-solvent</td><td rowspan="2">Steam Solvent</td><td rowspan="2">Chemical water treatment</td><td>RT-OTSG</td></tr>
<tr><td>Steam-solvent Cogen</td><td>SOFC</td></tr>
<tr><td>Pure Solvent</td><td>Pure Solvent</td><td></td><td></td></tr>
</table>

Key: OTSG – once-through steam generation boiler; RT-OTSG – Riffle tube once-through steam generation boiler; Magox – Magnesium oxide; DCSG – Direct contact steam generation and SOFC – Solid oxide fuel cell

The optimal technology configurations could be classified either as applicable to Brownfield or Greenfield or both depending on where the configuration can be applied suitably. Technologies that can be easily retrofitted into existing SAGD infrastructure with modest capital expenditures are considered as Brownfield whereas those that require an almost complete change of the existing infrastructure are Green field. Greenfield configurations will be uneconomic as retrofits.

RESULTS

The economics and emissions reduction potentials of various technology segments are assessed and the results are presented in this section.

GHG Emissions Reduction from New Technologies. The ranges of process fuel –derived GHG emissions obtained under the various segments are shown in Figure 1. Whereas all the technology segments can reduce process fuel–derived GHG emissions of the *SAGD Base* case (60.4 $kgCO_2eq./bbl$ bitumen shown with a dash line in Figure 1), two technology segments (the RES and SG) show the greatest potential for emissions reduction. The RES and SG segments can independently reduce direct fuel-derived GHG emissions of the *SAGD Base* case by 70-75%. This is achieved by the pure

solvent-based extraction and direct contact steam generation (DCSG) technologies. The DCSG case assumes that 30%-60% of the CO_2 generated from oxy-fired natural gas combustion is sequestered in the oil sands reservoir during the bitumen extraction process. The process descriptions of these technologies are presented elsewhere (Nduagu et al., 2017). In terms of GHG reductions, electromagnetic heating, which is among the RES technologies reduces emissions quite significantly (55% less than SAGD baseline when natural gas combined cycle is used). However, electromagnetic heating technology uses more electricity than other RES technologies, and when emissions from electricity generation are included, its emissions reduction potential is reduced dramatically.

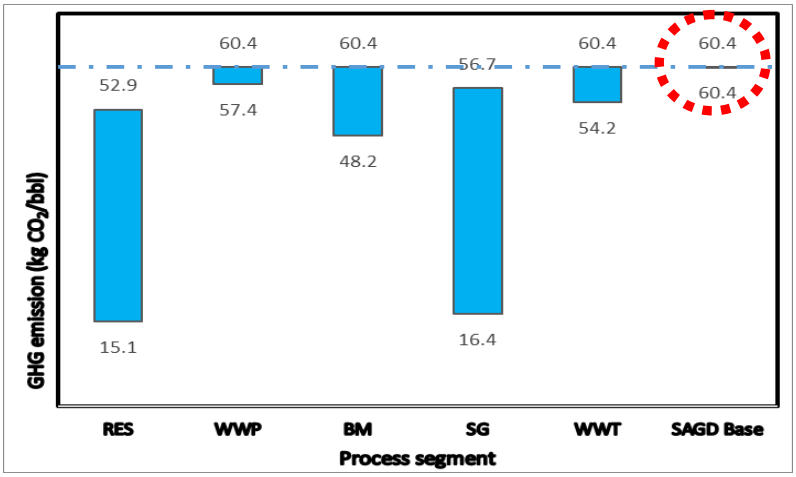


Figure 1. Range of direct GHG emissions for various bitumen extraction process segments. Key: *RES* – Reservoirs; WWP - Wells and wellpads; *BM* - Business Management and Data Analytics; SG - Steam Generation; *WWT* -Water and Waste Treatment and *SAGD Base* – conventional *SAGD* process used as basis for comparison.

Cost Reduction from New Technologies. Supply cost results in Figure 2 show that only the RES segment constitutes emerging technologies that can dramatically reduce SAGD bitumen supply costs and may even increase the cost significantly. The supply costs under the RES segment is between C$29.6/bbl and C$64.1/bbl bitumen (as against C$43.3/bbl bitumen for the *SAGD Base*) if steam-solvent technologies are deployed in a Greenfield facility.

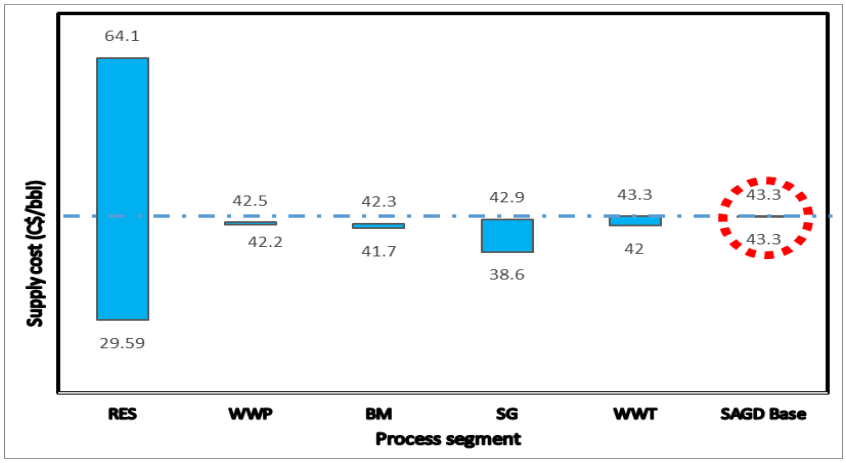


Figure 2. Range of supply costs for various bitumen extraction process segments. Key: RES – Reservoirs; WWP - Wells and wellpads; BM - Business Management and Data Analytics; SG - Steam Generation; WWT -Water and Waste Treatment and *SAGD Base* – conventional SAGD process used as basis for comparison.

Under *RES* segment, the steam-solvent extraction processes show the greatest potential for cost reduction. The lowest cost value (C$29.6/bbl) represents high performance steam-solvent processes that can reduce the SOR of the SAGD (3 m^3/m^3) base case by 35% and produce a bitumen production uplift of 38% over the *SAGD Base* case. If a lower range of 10.5% production uplift is applied, the supply cost of the steam-solvent process becomes C$0.50/bbl less than that of the *SAGD Base* case. It can then be deduced that *SOR* reduction and production uplifts are key factors that influence the economics of the steam-solvent process.

Other technologies with moderate cost reduction potentials within the supply costs range for the RES segment are the *Pure solvent* (C$39.9/bbl bitumen) and the *Steam-surfactant* (C$41.8/bbl bitumen) processes. However, these technologies produce partially upgraded bitumen products. For example, a *Pure Solvent* process such as *NSOLV* uses propane or butane as solvent for bitumen extraction and produces a lower viscosity bitumen product with an API gravity of 13-14 as against raw bitumen's API gravity of 8. Consequently, a diluent cost of C$4/bbl can be avoided in supply cost of SAGD bitumen on a Western Canadian Select equivalent (WCS eq.) basis. Diluent reduction also frees up pipeline volume allowing more bitumen to be transported. Though water consumption footprint is not covered in this study, it is worth mentioning that the solvent processes have the potential to reduce water use in oil sands extraction to zero, and thus, reducing the requirements for water treatment facilities. However, the solvent-based processes face concerns of loss of solvent and uncertainties about the long-term fate of the unrecovered solvent in the reservoir.

The upper range of the *RES* segment represents maximum supply costs for the electromagnetic heating technologies. With electromagnetic heating, a range of supply costs of bitumen (C$48.7/bbl to C$64.1/bbl) is obtained depending on the number of wells and durability (lifespan) of the heating antennas. This technology also uses pure solvent but is heated electromagnetically. Similar benefits of partial upgrading and zero water use footprints are expected, but the supply costs are prohibitively high.

The BM segment achieves notable economic and environmental performance, particularly in the application of data analytics in steam flood optimization, which results in considerable emissions reduction and higher return on investment (low adoption cost but relatively high performance).

Performance Improvements from Technology Configurations. Considering both cost and GHG emissions minimization objectives, an optimal process was observed to be the *Steam Solvent CoGen* configuration (Figure 3).

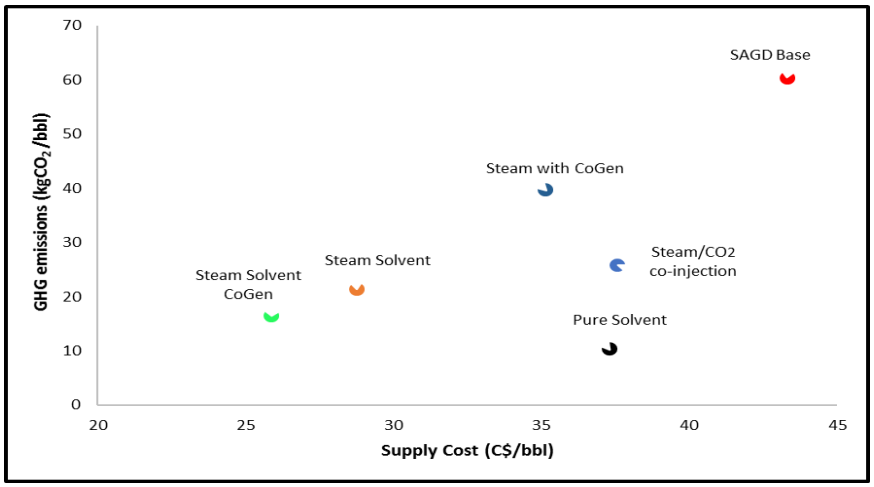


Figure 3. Combined impact of technologies under different cost and GHG emissions scenarios

This process uses solid oxide fuel cells (*SOFC*) for steam and electricity generation and has the potential to reduce costs and GHG emissions of the *SAGD Base* by 40% and 73%, respectively. However, this technology still needs further development and may face significant technical

maturity and economic issues if implemented in an oil sands facility. Another near optimal technology configuration is the *Steam Solvent* configuration with most of its process components almost commercial. Thus, this configuration seems more feasible than the *Steam Solvent CoGen* configuration.

On the other hand, the *Pure Solvent* technology configuration has the potential to achieve the highest emissions reduction, an 83% reduction of fuel-based GHG emissions of the *SAGD Base*. This is a configuration of choice if the objective is to reduce fuel-derived emissions of oil sand to near zero. Only the *Steam Solvent* technology configuration is applicable to the Brownfield. This configuration requires minimal retrofits and uses data analytic-based steam flood management to optimize steam injection and bitumen mobilization.

Oil Sands Emissions Profile and the 100 $MtCO_2eq$. Cap. Using production projections (Millington, 2017) and fuel-derived and fugitive emissions intensities of mining, *in situ* production, primary production, enhanced oil recovery, and upgrading, annual emissions profile of the Alberta oil sands industry are assessed (Figure 4). Recently, the Alberta Government introduced a 100 $MtCO_2$ eq./year emissions cap regulation aimed to limit oil sands emissions (Government of Alberta, 2016a). The cap is shown in Figure 4 as a horizontal red line. The profile "*Total Direct Emissions with CH4 Policy*" is the business as usual case where no new technologies are used and the Alberta methane policy (Government of Alberta, 2016b) of achieving 45% reduction of methane emissions from oil and gas industry against 2014 levels is implemented. The methane policy will result in an emissions reduction of less than 2 megatons CO_2 equivalents per year (Mt CO_2/year) which will, however, be dwarfed by emissions growth associated with increasing bitumen production.

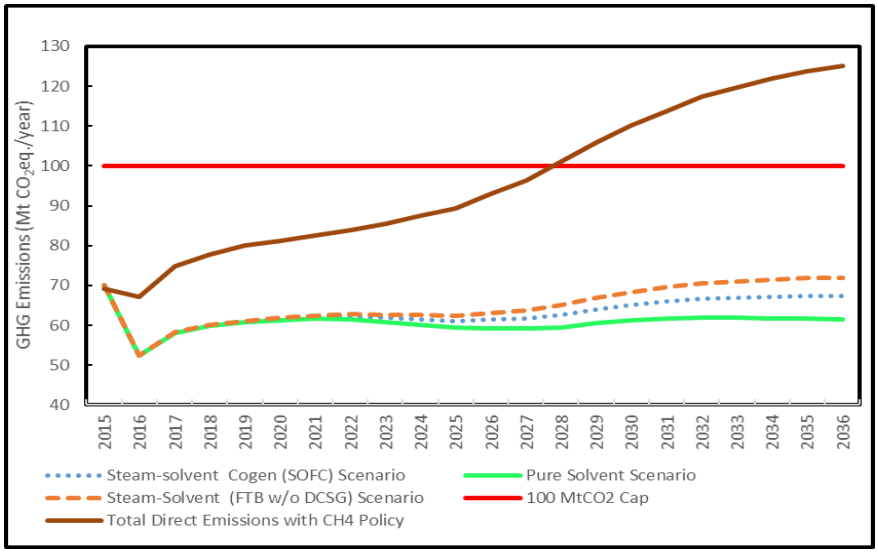


Figure 4. Combined impact of technologies under different cost and GHG emissions

The optimal cost and emissions technology configuration profiles (Fig. 4) are the "*Steam-solvent Cogen (SOFC) Scenario*" and the "*Steam-Solvent (FTB w/o DSCG) Scenario*"; however, the later seems to be plausible given its level of technical maturity. The "*Pure Solvent Scenario*" is the profile for minimum emissions. The emissions profiles are a product of the emissions intensity (including fuel-derived, flaring and fugitive emissions) and the bitumen production expressed in Mt CO_2e/year.

The observed deviation in the emission profile in Fig. 4 can be explained by the downturn due to global oil glut and Alberta wildfires in 2016. Our results indicate that the "*Total Direct Emissions with CH4 Policy*", which indicates the business as usual case, would reach the 100 Mt CO_2/year cap by 2026 whereas under the alternative scenarios, the industrial emissions cap is not reached over the 20 years' production window considered.

CONCLUSIONS

New technologies that are deployable for *in situ* bitumen extraction and processing show potential to reduce supply costs and emissions impacts significantly. Our optimal technology configurations can reduce costs and fuel-based GHG emissions by up to 34-40% and more than 80%, respectively. However, realization of these potentials will depend largely on technical progress and funding towards commercialization of these technologies.

References

Millington, D. 2017. Canadian Oil Sands Supply Costs and Development Projects (2016-2036). Canadian Energy Research Institute Report, Study No. 163. February, 2017. Calgary, Alberta, Canada. Available at http://resources.ceri.ca/PDF/Pubs/Studies/Study_163_Full_Report.pdf

Nduagu, E., Sow, A., Umeozor, E., Millington, D. 2017. Economic potentials and efficiencies of oil sands operations: Processes and technologies. Canadian Energy Research Institute Report, Study No. 164. March, 2017. Calgary, Alberta, Canada. Available at http://resources.ceri.ca/PDF/Pubs/Studies/Study_164_Full_Report.pdf

Government of Alberta, 2016a. Capping oil sands emissions: Transitioning to an output-based allocation approach and a legislated limit to oil sands emissions under the Climate Leadership Plan. Available at https://www.alberta.ca/climate-oilsands-emissions.aspx

Government of Alberta, 2016b. Reducing methane emissions: Methane emissions in Alberta will be reduced by 45% by 2025 under the Climate Leadership Plan. Available at https://www.alberta.ca/climate-methane-emissions.aspx

ABSTRACT ID# 407

INTEGRATING CLIMATE CHANGE INTO DEVELOPMENT ASSISTANCE AND BUSINESS CASES IN 15 COUNTRIES

Sibout Nooteboom

Abstract

In the 2015 Paris Agreement, developed countries reconfirmed their collective goal to assist developing countries in reaching their goals for climate change adaptation and mitigation. The Netherlands is committed to do its share as an integral part of its development assistance. This paper describes the Netherlands actions in integrating climate change in its programmes and contributing to global climate objectives.

Introduction

At the Paris climate conference in December 2015, 195 countries set out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C, to track progress together, to strengthen societies' ability to deal with the impacts of climate change and to provide continued and enhanced international support for adaptation to developing countries for dealing with its consequences. To put such commitments into practice, developed countries intend to continue their existing collective goal to mobilize USD 100 billion per year by 2020 to support developing countries, and agreed to continue to mobilize finance at this level until 2025. This paper describes and evaluates effectiveness of the Dutch approach in dealing with climate change as a complex development policy problem. It first describes climate change as a complex policy issue, and then continues to explain how The Netherlands has integrated it into sectors that are relevant to the problem, aiming among others to seduce private actors to join in. Potentially effective tools are described, including Impact Assessment. Conclusions are based on reflection by practitioners in this process.

Climate change as policy problem

The challenge is to meet commitments on the input side (dollars) as well as on the impact side (climate change mitigation and adaptation). Effective response to climate change mitigation and adaptation depends on sectoral transformations or, even more complex, societal transitions for both developed and developing countries. There is an emerging literature examining the numerous interdependencies, linkages and spill-overs that exist among complex (and climate-influenced) energy, food and water systems ('nexus'), implying that the governance of these systems should be conducted in an integrated manner that seeks to minimize trade-offs and maximize synergies Wakeford et al (2016). Myriad interventions are required, from redesigning of institutions to promoting gender equality (e.g. (Termeer et al., 2016; Gupta et al., 2010). Mazzucato (2016) asserts that the required sustainable transformations depend on new markets, created by governments in a public-private governance process.

Proposed development and climate solutions may fail to meet the long-term climate challenges. For example, hydropower is commonly considered a renewable energy alternative to high GHG emission fossil fuel based energy. However, the large dams that generate hydropower are increasingly being

called into question not only for the social, environmental and economic risks they create, but also because of their vulnerability to climate-related drought and GHG emissions. New, proactive forms of impact assessment create a financer's dilemma: either proceed with available proposals for shorter-term benefits with long-term risks, or first require that proponents get their governance in order – i.e. adopt a nexus approach, leading to transparent and informed strategic decisions (DSU, 2016a).

The Paris Agreement encourages subscribing states to commit to Nationally Determined Contributions (NDCs), and to collaboratively implement the proposed climate actions for adaptation and mitigation (see the readiness programme of the Green Climate Fund, GCF). Climate change units within the government may be tasked to mainstream (integrate) climate change into relevant ministries' development plans and programmes. Forms of impact assessment are one way to stimulate inter-agency cooperation in mainstreaming climate change (e.g. EU, 2016). However, climate change units (and environment ministries) have relatively little authority or budget to enforce climate mainstreaming or monitor results (e.g. Howes et al., 2015).

The Dutch approach

The Dutch 'fair share' of the developed country Parties contribution to climate finance is estimated by the Netherlands national court of audit to be up to €1.2 billion in 2020. The Netherlands' policy is to integrate climate action into its development policies and activities aiming to increase resilience. It intends to do so by reducing vulnerability and adapting to the potential impacts of climate change, lowering GHG, and reducing disaster risks. It refers to this approach as 'climate-smart' development. Dutch climate finance is from public finance, the Dutch official development assistance (ODA), and from private sector climate finance.

The Ministry's climate team took the lead in the mainstreaming efforts and focused on assisting the embassies and central departments that are responsible for programs related to food security, water management, security and rule of law, and private sector development. Most ODA is centrally managed from The Hague. However, the Netherlands also works with 15 partner countries, of which 10 in sub-Sahara Africa, where embassies manage significant bilateral programmes that support the priority themes. It was recognized that embassies and departments lacked technical climate knowledge and information and that there had not been comprehensive reporting on climate change results or climate finance contribution. It was also recognized that since there were programmes already in place, the integration of climate change would initially focus on on-going initiatives and set the groundwork for future programming. Efforts were also made to address the [inaccurate] perception by programme managers (e.g. heads of food security or water programmes) - that climate change was yet another administrative hoop to jump through with little relation to the development results that they were working to achieve.

These efforts included the preparation of a Climate Change Profile for each of the countries in which there was a development programme (DSU, 2016b). The objective of the Climate Profile is to provide a brief (± 15 page including maps) overview of the projected impact of climate change in the country, including a specific focus on food security and water, the country's climate change policies, NDC, and programmes, and Dutch and international climate-related actions. By providing information on geographic and sector climate risks the profiles assist embassies in preparing new projects and programmes. A climate screening guideline (MFA, undated) was prepared and used by many of the embassies and the centrally managed food security and water programmes to screen projects to

assess their contribution to climate adaptation and or mitigation. To improve reporting on climate change activities and contribution to climate finance, there is a rigorous application of the Rio Markers (OECD 2016) for each project. Capturing the embassy's response to climate change an annual 'pitch and bid' (MFA, undated) is prepared – a brief (2-page) report that includes each project's contribution to climate change (adaptation and mitigation) both anticipated development results and climate finance contribution. Supporting the embassies are in-country climate workshops (which include interactive impact assessments), an annual climate –smart workshop, and for both embassies and central departments climate e-courses, inclusion of climate in sector e-courses such as food security, an on-line climate-helpdesk. In addition, Mainstreaming Guidelines (MFA, undated) were developed that help embassies and central departments in mainstreaming climate change into their development policies and programmes. The generated climate-smart ideas are integrated into on-going and future programs.

Discussion

While currently on track for a Dutch fair share of climate finance, several further questions emerge:

1) **Did impact assessment contribute?** The mainstreaming approach used by the Netherlands ministry included a requirement to assess the climate impacts and opportunities of development programmes that do not have climate mitigation or adaptation as their primary objective. The Netherlands has done this with the mainstreaming approach described as it urged programme managers to explain how they contribute to climate change objectives, and offered them methodology in terms of process and content. It is the authors' impression, as reflective practitioners, that it has made a difference. The induced conversations between programme experts and climate experts appear to have given insights that may influence future programs. Netherlands is not unique. Donors, for example, help the government of Mali to apply environmental assessment with a similar aim (GIZ, 2016).
2) **How to define ODA climate adaptation results?** For public and private investors to show sustainability effects, they need to agree on a way to measure. While there are challenges to measuring mitigation, the criterion is clear – put simply, it is GHG emissions, with accepted models for estimates and reporting. However, adaptation does not have such a single indicator, especially when considering long-term resilience rather than short-term gain. The mainstreaming and 'from aid to trade' approach also create reporting problems for climate change: even if fully integrated, the result areas need to be chosen pragmatically with a focus on a few quantitative indicators for which data can be collected in a food security or water programme. However, the indicators provoke discussions as to how to collect information on climate change when it is integrated into a food security or water programme. The GCF is developing an investment framework, a performance monitoring system, and country ownership guidelines which may prove useful for the Netherlands and other countries that are working to report climate results within a mainstreaming approach. Informal impact assessment workshops have benefited the Dutch mainstreaming approach. Reporting the progress of such learning efforts – e.g. to which extent do impact assessments inspire implementing experts and contribute to climate-smart ODA? - may be a necessity to maintain political support for climate finance.
3) **How to encourage climate-smart/sensitive investment?** Some investments are intrinsically (if not explicitly) engaged in climate-sensitive activities such as energy, transport, agriculture

and infrastructure. Climate change is an added complexity, which must be brought into the equation as a future constraint, but in an approach, that provides incentives and encourages investment. Such incentives may "tilt" the level playing field delicately toward climate smart investments, by means of government interventions like specific infrastructure investments, regulations and market based instruments. While investment incentives for climate-smart value chains were mentioned to some degree in climate screening workshops, 'pitch-and-bids' reports, project designs, and in the aid to trade discussions, much remains to be learned and applied.

Further reflections would be needed to formulate researchable questions about how the Paris agreement can contribute to more business cases for private climate investments.

References

DSU, 2016a. Better Decision-Making about Large Dams with a View to Sustainable Development. Advisory Report by the Dutch Sustainability Unit. Utrecht

DSU, 2016b. Climate change profiles for Dutch partner countries. Utrecht

EU, 2016. Integrating the environment and climate change into EU international cooperation and development. Towards sustainable development. Guidelines No 6, Tools and Methods Series Directorate-General for International Cooperation and Development European Commission

GIZ, 2016. Launch of the national adaptation plan process in Mali. Website, accessed February 2017 https://www.international-climate-initiative.com/en/news/article/launch_of_the_nap_process_in_mali/

Gupta J. (Joyeeta), C.J.A.M. Termeer (Catrien), J. Klostermann (Judith), S. Meijerink (Sander), M. van den Brink (Margo), P. Jong (Pieter), S.G. Nooteboom (Sibout) and E. Bergsma (Emmy), 2010. The Adaptive Capacity Wheel: A method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Environmental Science & Policy, Volume 13 - Issue 6 p. 459- 471

Howes Michael, Peter Tangney, Kimberley Reis, Deanna Grant-Smith, Michael Heazle, Karyn Bosomworth, and Paul Burton. Towards networked governance: improving interagency communication and collaboration for disaster risk management and climate change adaptation in Australia. Journal Of Environmental Planning And Management Vol. 58 , Iss. 5, 2015

Mazzucato Mariana, 2016. From market fixing to market-creating: a new framework for innovation policy. Industry And Innovation Vol. 23 , Iss. 2, 2016

MFA, undated. Titles refer to unpublished working documents of the Ministry of Foreign Affairs.

OECD 2016. OECD DAC Rio Markers for Climate: Handbook. Undated website, Accessed January 2017

Termeer Catrien J.A.M., Art Dewulf, and G. Robbert Biesbroek. Transformational change: governance interventions for climate change adaptation from a continuous change perspective. Journal Of Environmental Planning And Management Vol. 0 , Iss. 0,0 2016

Wakeford J.J., S.M Lagrange, C. Kelly, 2016. Managing the Energy-food-water-Nexus in Developing Countries: Case Studies of Transition Governance. QGRL WORKING PAPER No. 2016/01

COMPARATIVE ANALYSIS OF VULNERABILITIES OF SELECTED COASTAL COMMUNITIES AND POPULATIONS TO CLIMATE CHANGE IMPACTS AND ADAPTATION STRATEGIES IN NIGERIA AND SENEGAL

***Ojile, M.O.[1], Koulibaly, C.T.[2] & Ibe, C.[3]**
[1] Department of Geography & Environmental Management, Niger Delta University, Wilberforce Island, PMB 071, Yenagoa, Bayelsa State, Nigeria; Email: mesh_owho@yahoo.com
[2] Institute of Natural Resources, Environment & Sustainable Development (INRES), University of Port Harcourt, Nigeria & Doctoral Student@ Coastal Zones Management, Cheikh Anta Diop University of Senegal;
[3] Professor @ INRES, University of Port Harcourt, Nigeria.

Abstract
A comparative analysis of differential vulnerabilities and adaptation strategies to climate change impacts of selected coastal communities in Nigeria and Senegal was undertaken. Nigeria's Niger Delta Coastal communities in Delta-Bayelsa States were selected as study area while along the Senegalese coasts, 3 areas were selected from the North to the South. A combination of different data acquisition methods was employed: field studies, documentation, literature reviews and other enriching enquiries. Beginning from an environmental and socioeconomic baseline description of the selected Niger Delta and Senegalese communities, the differential vulnerabilities to climate change impacts were well stated before an analysis of the different adaptation strategies employed to withstand the effects of climate change was undertaken. Some similarities and dissimilarities in adaptation strategies were observed. The study showed that, although the vulnerabilities of these coastal communities are almost the same, the adaption strategies employed are different, mediated as it were by differences in cultures, different environments and socioeconomic activities as well as different capacities to cope with observed climate change impacts. Given the disastrous environmental and socioeconomic impacts of climate change on coastal zone communities, the study recommends the building of proper and better adaptation strategies to reduce the vulnerabilities of these coastal communities to climate change and these require actions that must be undertaken from the Community level to the Regional, National and International levels.

Key Words: *Nigeria/Senegal, Climate Change, Coastal Communities, Differential Vulnerabilities, Adaptation strategies*

INTRODUCTION

Impacts on coastal systems are among the most costly and most certain consequences of a warming climate (Nicholls et al., 2007). Coastal shorelines will be eroded while low-lying areas will tend to be flooded more frequently or permanently, by the rising sea. Accelerated sea level rise (SLR) represents a significant planning and management challenge to coastal nations, especially in developing countries where vulnerability is high, adaptation options are limited, and spatial data and information are limited for planning purposes (Brown et al., 2014). SLR has already resulted in increased erosion and inundation of vulnerable areas, threatening both lives of people who inhabit coastal environments and property as well as marine resources. Sea levels are expected to rise around Africa, and impacts include flooding, saltwater intrusion, loss of beaches and recreational activities including tourism, loss of infrastructure, and changes to river flows and outputs on the coast. In Africa, data are generally missing on the present rates of sea-level change, coastal geomorphology, and socioeconomic trends (Hinkel et al., 2012).

With over 3,700 km of coastline, the West African Marine Eco-Region (WAMER) has a high percentage of its population concentrated in coastal settlements and cities which are vulnerable to sea-level rise. The Intergovernmental Panel on Climate Change (IPCC) estimates that by 2020, more than 50 million people will inhabit the coast from the Niger Delta in Nigeria to Ghana's capital city, Accra (Joiner et al., 2012). Adaptation to the changes that affect the daily livelihood is a big challenge for coastal communities who must put in place efficient strategies to face the adverse impacts of climate change CIESIN (2011).

This study emphasizes the utility of comparing the vulnerabilities and adaptation to climate change in two different geographical areas with different populations, different cultures, perhaps different environments and economic activities and different capacities to cope with changes. Spatial vulnerability assessments are useful tools for understanding patterns of vulnerability and risk to climate change at multiple scales (de Sherbinin, 2014).

METHODOLOGY

Our selected areas in Nigeria's Niger Delta area are local communities located along the coastlines of Forcados – Escravos-Ramos Rivers Estuaries in Delta and Bayelsa States. In Senegal, selected local study areas are located from the North to the south: Saint Louis, the Saloum Delta and the areas of Rufisque-Bargny (Fig.1).

Various methodologies were employed in the research. As a comparative study involving two countries, different means were adopted to get relevant data. The situational context of the areas, availability of resources and accessibility of selected study sites were all considered. Following the peculiarity and insecurity situation that prevailed in the Niger Delta at the time

*Correspondence Author

of study, a desktop study and reliance on available materials was utilized, drawn mostly from the environmental studies carried out by one of the authors. From the Senegalese axis, a set of field activities were organized and included: physical data collection using direct observation, transect walks, pictures and GPS coordinates of targeted sites.

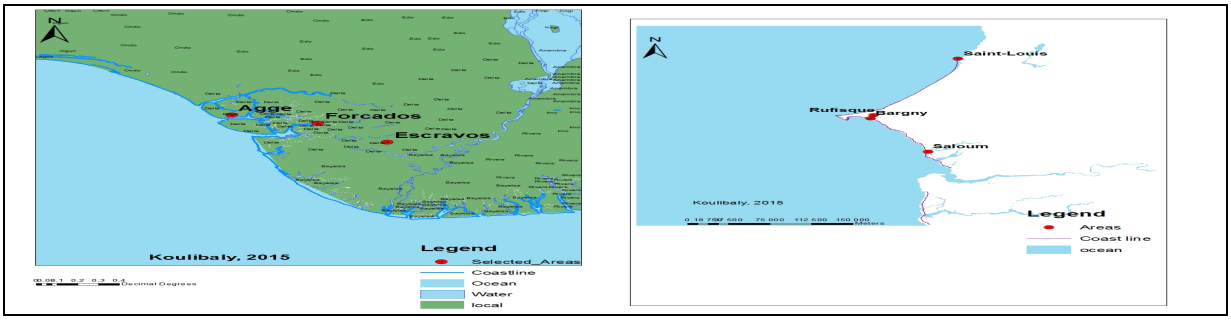


Figure 1: Selected Areas in the Niger Delta, Nigeria (left) and southern parts of Senegal

RESULTS AND DISCUSSION

Socioeconomic aspects of Nigeria's Niger Delta and Senegalese Coasts

The Niger Delta region is a low-lying area consisting of several tributaries of the Niger River and ending at the edge of the Atlantic Ocean. The region occupies about 112,110 km^2 and represents some 12% of the country's total surface area. With a coastline spanning about 450 kilometers terminating at the Imo River entrance, the region spans over 20,000 km^2 which has been described as the largest wetland in Africa and among the three largest in the world (UNDP, 2006, NDDC, 2006, CREDC, 2007). About 2,370 km^2 of the area consist of rivers, creeks and estuaries and stagnant swamp covering about 8600 km^2 (CREDC, 2007). With an annual growth rate of 2.9%, the region is home to over 37 million people (NBS, 2012). Nigeria's economy depends on oil and gas extraction from the Niger Delta as the main source of foreign exchange.

The Ijaws and Itsekiris predominate as ethnic groups in the coastal study area (Delta and Bayelsa State). Majority of the coastal habitations along the Forcados-Escravos-Ramos Rivers estuaries' are small settlements devoid of high concentrations of population because expansion is limited by a lack of dryland. The combined population of the group of coastal communities in the study area ranges from 100,000 to 150,000 with an average annual growth of 2.5%. Population densities are high in some areas and moderate in others; 116 persons per km^2 in Delta and 148 in Bayelsa axis and not uncommon to find communities of >500 persons /km^2. Economically, the livelihood of the coastal population revolves around fisheries and trading. The proportion of persons effectively engaged in fishery activities ranged from over 45% to over one half, although inhabitants of some of the coastal communities are 100% into fisheries (Ojile, 2014, 2013, 2008).

Six regions cut across the **Senegalese coastline**: *Saint-Louis, Louga, Thiès, Dakar, Fatick* and *Ziguinchor* and further divided into 4 large geographic areas: *Grande-Côte, Cap-Vert, Petite-Côte and Casamance.* The region was once estimated to house 3.45 million people in 1988, about 50% of the population (Niang-Diop, 1995; Hatziolos et al., 1996), but now thought to be inhabited by 60% of the country's population (7.8 Million) (World Bank, 2014). Some 10 different ethnic groups speaking different languages and dialects live along the coast. In Saint Louis area, the *Guet-Ndariens* and *Lebous* are the predominant communities; conducting artisanal fishing in its tributaries like their Delta counterparts in Nigerian coastline. In the Saloum Delta area, populations are the *Sereres Niomimkas*, who are also artisanal fishermen and farmers. Economically, the major livelihood of the Senegalese coastal communities is traditionally fishing, involving more than 600 000 individuals. Subsistent farming in form of gardening and paddy-rice cultivation also thrive.

Vulnerabilities of the Coastal Communities to Climate Change:

Several studies conducted over the years indicate that Nigeria's Niger Delta is very vulnerable to climate change impacts and particularly sea level rise, flooding, inundation and coastal erosion. Vulnerability indicators of topography, coastal slope, relative sea level rise, annual shoreline erosion rate, mean tidal gauge, population density and proximity to the coast testify to the vulnerabilities of coastal communities and population in the past, presently and into the future (Musa, et al., 2014; Rosmorduc, 2012; Oyegun, et al., 2016; French *et al.*, 1995; Folorunsho and Awosika, 2000; Ibe, 1986, 1988; Awosika et al., 1992). Many of the settlements are exposed to shoreline dynamics owing to distance from the shoreline. Bayelsa, Rivers and Delta States are almost 50% exposed with a mean distance of 16.10, 14.86 and 16.79km respectively. Some 349 communities are reportedly vulnerable to coastal dynamics with Bayelsa and Delta having 95 and 68 of their communities susceptible to climate change impact (Oyegun, et al., 2016). All of the settlements/communities situated along the Forcados-Escravos-Ramos Rivers Estuaries typically suffer from climate change impacts. River bank collapse, eroding coastline, submerged electric poles and loss of houses are proofs of the serious effects of coastal erosion in the area.

*Correspondence Author

The vulnerabilities in Senegal are not too different; a flat topography (<50m of elevation) of 75% of the territory makes it susceptible to inundation and coastal erosion. SLR in the Saint-Louis axis is predicted at about 20cm by 2030 and 80cm by 2080 while 3cm had been recorded between 1990 and 2010. In 1975 a beach retreat of 1.2m had been recorded while this number shifted to 3.2m in 1989. Positions of high water mark limit on aerial photographs and satellite images between 1954 and 2006, shows a significant regression of the beach of Rufisque from 0.4-1.5m per year (IUCN, 2010) and in the Palmarin coastal area, more than 200 meters of land has been lost; including loss of dwellings and economic assets. Saltwater intrusion is now more frequent in both the Saloum Delta region and Saint-Louis, threatening household water supply. In the Cape Vert peninsula, 1m of SLR will lead to losses of beaches and inundation with an estimated population of 847,000 – 11,807,000 at risk (Niang Diop et al, 2010)and in Bargny, about 300 buildings housing almost 2250 dwellers are estimated to be impacted (World Bank, 2014). Communities lying along sand spit of Langue de Barbarie in Saint-Louis area, are experiencing huge storm surges and 52 families were displaced or relocated in 2010 (Kane 2010). The total cost due to the damage caused by inundation is estimated about USD1,636 billion while the cost due to coastal erosion will reach USD24.6 million (USAID, 2012).

Adaptation Strategies in coastal communities

Nigerian and Senegal coasts are very strategic areas because of the relevant benefits they provide for their countries and resident populations. But, in both countries, the impacts of climate change have been observed and felt for decades by coastal communities but now require more concerted actions to arrest the situation.

For now, affected communities have developed some ingenuous local strategies to fight their problems. For the Nigeria's Niger Delta coastal communities, common adaptation techniques employed include: i) use of *Sand Bags* along the shore; ii) river embankments; iii) construction of canals and channels; iv) building of dwellings on stilts/raised platforms to prevent homes from being washed away by flood and rising sea water; and v) government interventions in form of construction of engineered walls/shore protection embankments.

Similar preventive and adaptation measures but broader in scope are employed in Senegal: i) Sand-Bags fortified with nets to bind together and improve resistance; ii) use of half-buried tires or logs of wood reinforced with sand bags; iii) use of cement blocks by households as walls to protect dwellings against waves and erosion; iv) use of empty sea shells (usually oysters) dumped and accumulated over time; vi) Mangroves reforestation campaigns as natural barriers against storm surges; and vii) high engineering projects of huge structural nature - Dykes, breakwaters, and walls.

CONCLUSION

Coastal zones are highly vulnerable to climate change and its impact. Settlements are eroded, flooded/inundated, and salinization of aquifers which highly impede livelihoods, quality of life and community development. The coastal communities have developed local but temporary adaptation strategies to protect their settlements/dwellings and sustain their livelihoods against climate change related disasters. Government interventions involve huge engineering construction of seawalls and dykes. Nigeria's Niger Delta coastal communities have long adapted to dealing with flood while the Senegalese coastal communities are more attuned to dealing with coastal erosion/regression. But better adaptation strategies to reduce the vulnerabilities of these coastal communities to climate change is now canvassed, requiring actions that must be undertaken from the Community level to the Regional, National and International levels.

*Correspondence Author

REFERENCES

Awosika, L. F., French, G. T., Nicholls, R. J. and Ibe, C. E. (1992). *The impact of Sea level Rise on the Coastline of Nigeria.* In: Proceedings of IPCC Symposium on the Rising Challenges of the Sea. Magaritta, Venezuela. 14-19 March, 1992.

Awosika, L. F. (1995). Impacts of global climate change and sea level rise on coastal resources and energy development in Nigeria. In: Umolu, J. C. (ed). *Global Climate Change: Impact on Energy Development*. DAMTECH Nigeria Limited, Nigeria.

Brown, S., Nicholls, R. J., Hanson, S., Brundrit, G., Dearing, J. A., Dichson, M. E., Woodroffe, C. D. (2014). Shifting perspectives on coastal impacts and adaptation. *Nature Climate Change*, 4, 752-755.

Center for International Earth Science Information Network (CIESIN), Columbia University, (2012). National aggregates of geospatial data: Population, landscape and climate estimates, v3 (PLACE III), Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC).

Community Research and Development Centre of Nigeria (CREDC) (2007). Coping with Climate Change and Environmental Degradation in the Niger Delta of Southern Nigeria. 31 Pages.

de Sherbinin, A. (2014). *Spatial climate change vulnerability assessments: A review of data, methods and issues*. Technical paper for the USAID African and Latin American Resilience to Climate Change (ARCC) project. Washington, D.C.: USAID.

Hinkel, J., Brown, S., Exner, L., Nicholls, R.J., Vafeidis, A.T., & Kebede, A.S. (2012). Sea-level rise impacts on Africa and the effects of mitigation and adaptation: an application of DIVA. *Regional Environmental Change, 12*(1), 207-224. Retrieved from 10.1007/s10113-011-0249-2

Ibe, C. (1990). Global Change and the Vulnerability of the Nigerian Coastal Zone to Accelerated Sea Level Rise: Impacts and Response Measures. 39 Pages

Ibe, A.C., L.F. Awosika and E.E. Antia, (1984). Coastal Erosion Research Programme. Progress Report No.2, NIOMR Special Publication.

Joiner, E., Kennedo, D., & Sampson, J. (2012). Vulnerability to climate change in West Africa: Adaptive capacity in the regional context. In J. W. Busby, K. L. White & T. G. Smith (Eds.), *Student working paper no. 4*: CCAPS: Climate Change and African Political Stability.

Musa, Z. N.; Popescu, I. and Mynett, A. (2014). The Niger Delta's vulnerability to river floods due to sea level rise, Nat. Hazards Earth Syst. Sci. Published by Copernicus Publications on behalf of the European Geosciences Union.

Niang, Dansokho, Faye, Gueye, Ndiaye (2010). Impacts of climate change on the Senegalese coastal zones: Examples of the Cap Vert peninsula and Saloum estuary.

Nicholls, R. J., Wong, P. P., Burkett, V. R., Codignotto, J. O., Hay, J. E., McLean, R. F., and Woodroffe, C. D. (2007). Coastal systems and low-lying areas. Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. In O. F. C. M.L. Parry, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (Ed.), (pp. 315-356). Cambridge, UK: Cambridge University Press.

Ojile, M.O. (2014). Draft Socioeconomic (SIA) Report for the Bonga Field Oil Spill Post Impact Assessment (PIA) Study Submitted to Thermosteel Nigeria Limited, Warri, Delta State, Nigeria. 68pp.

…….. (2013a). Draft Socio-Economic (SIA) Report for the EER-Based EIA of Escravos Beach Upthrown Well Drilling Project, submitted to Mcgill Engineering and Technical Services Limited, Benin City. 64pp.

…….. (2013b). Socio-Economic (SIA) Report (Draft) for the EER Of Escravos Beach Flowstation, submitted to Thermosteel Environmental Services Limited, Warri, on behalf of SPDC. February 2013, 47pp.

---------- (2013c). Socio-Economic Characteristics/Community Health Report f*or the* Environmental Evaluation Studies (EES) of Chevron's Offshore Fields *Submitted To* Thermosteel Environmental Services Limited, Warri. *80pp.*

……. (2008). ''Socio-economic Characteristics of the Nigerian Coastal Environment''. A Technical Report. October 2008. 42pp.

Oyegun C. U., Lawal O., and Ogoro M. (2016). Vulnerability of Coastal Communities in the Niger Delta Region to Sea Level Rise. *Quest Journals, Journal of Research in Environmental and Earth Science, Volume 2~ Issue 8 (2016) pp: 01-08*

Rosmorduc, V. (2012). Information Services in support of West Africa Coastal vulnerability, Service 2: Sea Level Height and currents, Washington DC: World Bank.

*Correspondence Author

United Nations Development Programme (UNDP) (2006), Niger Delta Human Development Report 2006 UNDP, Nigeria, Abuja.

USAID (2012). Vulnerability Assessment of Central Coastal Senegal (Saloum) and the Gambia marine coast and estuary to climate change induced effect. Gambia-Senegal Sustainable Fisheries Project. 40 Pages

World Bank (2014) Economic and spatial Study of the Vulnerability and Adaptation to Climate Change of Coastal areas in Senegal. 123 Pages

World Bank Group (2014b), Senegal Economic Update, in Learning from the Past for a Better Future. 46 Pages.

*Correspondence Author

Application of Geodesign to Impact Assessment in Japanese Public Facility Management

Satoru ONO (Ritsumeikan Univ.)

1. Introduction

Public facility management is one of the most arrestive social issue in Japan. In 1960s to 1970s, a lot of public facilities were built in the urban areas of Japan because of the alarming economic growth and population concentration. On the other hand, since those facilities were architected based on previous building standards law, they are not satisfying the current standard for building.

In this situation, some local governments have started planning to rebuild them but there are mainly two limitations (Nemoto, 2011). The first is the change of public facilities' needs. The existing research is explaining that Japanese population will decrease in this century and highly aged society will come in near future. Second is the limitation of municipal budget. Because of the huge amount of deteriorated public facilities, it is obviously impossible for each municipality to rebuild all of them not only in short term but also in long term. Hence, planning approach (or so-called "triage" methodology) is seemed to be essential to promote public facility rebuilding and management effectively.

The existing research about Japanese public facilities management is mainly focusing on economic rationality. On the other hand, public facility management includes decommissioning and reduction of the part of the facilities and it can be thought as the cause of social impact to the area. It means the importance of planning approach in public facility management through environmental, economical, and social impact assessment. In this paper, "sustainability assessment" means an integrated impact assessment including environmental, economical, and social impact factors.

This paper aims to develop the theoretical framework of sustainability assessment in public facility management. Especially "geodesign" approach is focused on in this paper as an effective factor to promote communication between the stakeholders and decision making of public facility management through sustainability assessment process. To discuss about it, three research questions will be set explained in chapter 4, based on the Geodesign characteristics in chapter 2 and 3.

2. Characteristics of Geodesign in IA Context

Impact assessment is an application of systems analysis for decision making and it requires comparison between alternatives with

the respect to various indexes. Harashina (2000) suggest two major communication methodologies to satisfy the condition of impact assessment mentioned above –document based communication and meeting based communication. Harashina sets the goal of them to guarantee transparency of the assessment and decision making process.

On the other hand, especially integrative impact assessment such as sustainability assessment requires the validity of integration of various alternatives. This paper focuses on a communicative methodology named "Geodesign" as a solution to this problem. A decision-making method "Geodesign" has been developed and discussed by Dr. Carl Steinitz's research group (Steintz, 1990 Flaxman, 2010). In some municipalities, there are some application cases all over the world (Nyerges et. al., 2016) including Japan.

The decision-making method "geodesign" has been developed and discussed by Dr. Carl Steinitz's research group, and in municipalities, there are some application cases all over the world including Japan.

In this paper, communication by the means of geodesign will be analyzed through a case study in Yosano town public facility management in Japan.

3. Obstacles for Application of Geodesign to Impact Assessment Process

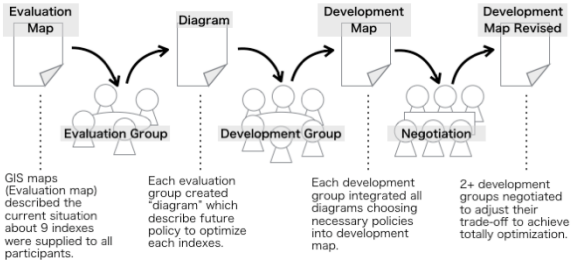


Fig. 1 Summary of Geodesign Workshop in Yosano Town Public Facility Management Process

3.1. Yosano town Geodesign Workshop

Yosano town is in the central region (Kinki Region) of Japan along Sea of Japan. It is facing population decreasing and aging society. Yosano town is making a grand vision (Master Plan) including public facilities management and planning to apply the geodesign methodology to planning process.

To conduct Yosano town's geodesign, "Geodesign Workshop" was held for 3 days. This workshop included 1 day of fieldwork in Yosano town and 2 days of discussion. 25 scientists participated to the WS and they were mainly young researchers specialized in geographic analysis, policy analysis, or computer science, such as PDs, Ph. D students, and master-course students.

The process of the WS is expressed in Fig. 1. In the WS, 3 kinds of GIS maps were supplied and created and 3 kinds of communications (evaluation group, development group, and negotiation) were held to assess the impact to environment, economy, and society by each plan (GIS map) and to integrate the various GIS maps.

3.2. Hypothesis of Obstacle for Geodesign Application

In this paper, the question "What is strength and limitation of Geodesign in IA process?" will be discussed. The methodology of geodesign is scientific and communicative, hence it will have a high affinity with impact assessment process to satisfy scientific aspect and democratic aspect of IA. On the other hand, there will be some difficulties in application of geodesign methodology to impact assessment such as;

1) **[resource and time limitation]** Geodesign is a communication process among scientists hence it is important to keep the balance between gathering various kind of scientists to guarantee the quality of communication and budget and time limitation,
2) **[understanding of information]** Impact assessment obviously requires information about the current situation of the environment, economy, and society in the project site. Because geodesign process based on the information expressed by GIS, this can be one of the greatest strengths of geodesign application to IA process, but it is also important to share such information among scientists correctly and sufficiently through an effective process design.
3) **[communication]** Impact assessment with Geodesign methodology includes communicative process among scientists. It can be effective to make decision based on integration of various alternatives through communication process, but it will be process design problem to make adequate environment to make scientists' communication effective and correct.

3.3. Research Method

To consider of the obstacles for geodesign application as above, the datum of the participants' recognition to Yosano town Geodesign WS was collected by the questionnaire survey and interview. Questionnaire survey was consisted of 4 main sections; A) understanding of GIS maps, B) understanding of Yosano town's condition, C) difficulty of the groupworks and negotiations, and D) the topic which the respondents would have wanted to discuss if there had been more time in workshop.

4. Analysis of Participants' Recognition – Considering of Three Research Questions

[*Could the participants discuss and negotiate about their opinion based on the various criterion*?] – Three types of group work and three types of inter-group negotiation were held in the workshop. Members in each group discussed and made the GIS map based on their

own theme while the backgrounds of them were different among each other. In addition, the working groups could change or adjust their plan on the GIS maps through the negotiation process. Hence, three questions about the participants' recognition can be extracted.

4.1. Communication in the WS

The first question is about difficulty of communication in the group work and the negotiation. The group work members had their own different backgrounds and there were big gaps of the understanding of Yosano town policy, geological condition, socio-economical condition and so on. One question is: "*Did the backgrounds and knowledge differences affect the participants' recognition about the deep communication in the work shop*?"

Fig. 2 and Fig. 3 are the descriptions of the participants' recognition about inter-group negotiations (Easy / Not Easy). According to the bar chart in Fig. 2, there is a statistically significant difference of negotiation recognition between "GIS experienced group" and "not GIS experienced group". On the other hand, there cannot be a significant difference between "Planning experienced group" and "not Planning experienced group" (Fig. 3).

It is obviously important to gather sufficiently skilled participants to geodesign based impact assessment to make, analyze, and revise the GIS map. These questionnaire results indicate the important role of GIS skills in geodesign based impact assessment to effectively integrate the maps through the inter-group negotiations and integrate the results of impact assessment by each group.

4.2. Understanding of GIS maps

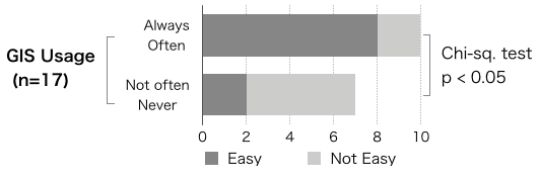


Fig. 2 Comparison of Participants' Recognition of Inter-group Negotiation with the respect to GIS usage

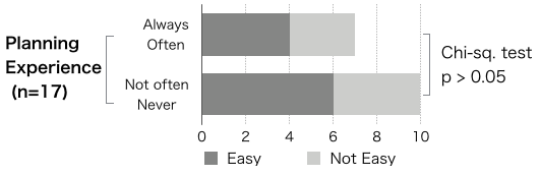


Fig. 3 Comparison of Participants' Recognition of Inter-group Negotiation with the respect to Planning Experience

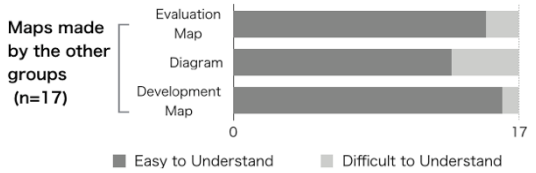


Fig. 4 Participants' Recognition of Difficulty to understand the GIS maps made by the other groups

The third question is about difficulty of understanding GIS maps made by other groups. In the group works and the negotiations, discussions and works were processed based on the GIS maps made by the other participants. On each GIS map, there was a description of the legend of all expressions, not only the name of the area and buildings but also a wide area of development and planning horizon. Hence the

GIS maps were complicated to understand the correct meaning. Then, a question that "*Did the difference of GIS maps understanding affect the participants' recognition*?" can be extracted.

From the questionnaire survey, there are greater answer "easy for me" to understand the evaluation map, diagram, and development map made by the other groups (Fig. 4), but some respondents pointed out the problem in the work shop process, e.g. "*the labels and the legends in GIS map was difficult to understand because there were little explanations about their meaning by the map developers*". Hence, the importance of communication among scientists in this kind of workshop has been suggested to process impact assessment based on sufficient understanding of the all the works from the any viewpoint.

4.3. Role of the scientists in impact assessment

The fourth is about the limitation of the participants' understanding about Yosano town. As explained in chapter 2, participation of scientists in impact assessment process is necessary and important, but Geodesign is an activity based on participants' GIS skills and understanding of local environment, culture, industry, and human activity in the planning area. Hence, the question "*Could the participants assess the social, environmental, and economic impact based on sufficient understandings about Yosano town*?" is important in considering the strengths and limitations of Geodesign application to impact assessment process.

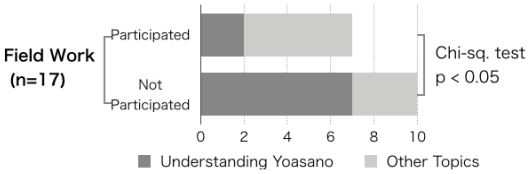


Fig. 5 Comparison of Participants' Recognition of the most important topic for Geodesign Application to Impact Assessment

Fig. 5 is a comparative bar chart about which topics should have been discussed or informed in this workshop if there had been more time. In this graph, the number of respondents who answered "time must be spared to share the information about Yosano town" in "Field work participants" group is significantly smaller than in the other group. Therefore, field work activity played a major part in sharing the information of Yosano town and it is pointing out the importance of information gathering activity as a preparation for Geodesign by scientists.

On the other hand, impact assessment is an assistive tool for sustainable decision making as explained in chapter 2. Hence, there should be not only preparative activity between scientists and local stakeholders but also interactive activity among them to conduct assessment based on sufficient information, scientific methodology, and democratic process. Some participants suggested in the final part of the

questionnaire "*Geodesign methodology will work better if there is a more interactive process between the Geodesign workshop participants, the public officers, and the citizens in Yosano town*". Geodesign application to impact assessment process is one of the powerful method to integrate various alternatives. However, a preparative and interactive process with local stakeholders should be added as a supplemental process to confront geodesign approach's limitation.

5. Conclusion

Through this participants' recognition analysis, strengths and limitations of Geodesign in IA process have been clarified. First, communicative process in Geodesign can be a major strength to apply to impact assessment process, but it is important to consider of the GIS experience gap among participants. Secondly, by sparing sufficient time to share GIS maps, participants can discuss and integrate the various alternatives through communication process. Finally, there is a need of interactive process between local stakeholders and scientists in order to keep the information correct. This is a limitation of Geodesign application to impact assessment process.

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References:

Michael Flaxman (2010) "Fundamentals of Geodesign", Proceedings of Digital Landscape Architecture

Sachihiko Harashina (2000) *Environmental Impact Assessment*, The Society for the Promotion of the Open University of Japam, in Japanese

Yuji Nemoto (2011) *Decaying Infrastructure*, Nikkei Books, in Japanese

Timothy Nyerges, Hrishikesh Ballal, Carl Steintz, Tess Canfiels, Mary Roderick, John Ritzman, Wilawan Thanatemaneerat (2016) "Geodesign Decision Dynamics about Sustainable Development: An Urban Watershed Perspective", Sustainable Cities and Society, 25, 13-24

Carl Steinitz (1990) "A Framework for Theory Applicable to the Education of Landscape Architects (and other Environmental Design Professionals)," Landscape Journal, Fall 1990, pp. 136 - 143.

Satoru ONO

Assistant Professor at Ritsumeikan University, Iwakura-cho 2-150, Ibaraki-shi, Osaka,

567-8570, Japan
sono.psrits@gmail.com

INDIGENOUS CULTURAL IMPACT ASSESSMENT: ADDRESSING THE CHALLENGES

Justin Page, PhD
Environmental Resources Management (ERM)
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INTRODUCTION

> "Aboriginal people told the Panel that the land-based or traditional economy is more than a means of providing physical sustenance; it is a way of life that sustains emotional, spiritual and cultural values as well." – *NWT Diamonds Project: Report of the Environmental Assessment Panel* (1996)

For indigenous peoples, environmental impacts are cultural impacts (Angell and Parkins 2011). While indigenous peoples have consistently raised such concerns, the Canadian environmental assessment (EA) process has historically either refused or been unable to adequately consider cultural impacts (McCormack 2016).

Ironically, the enactment of the *Canadian Environmental Assessment Act, 2012* (CEAA, 2012) marks a turning point in the consideration of indigenous cultural impacts in Canadian EA. CEAA, 2012 has been roundly criticized for reducing the scope of Canadian environmental assessment and the ability of the public to participate (Gibson 2012). Nevertheless, around the same time that the federal government enacted CEAA 2012, it sought to integrate the Canadian government's legal duty to consult with indigenous peoples into the EA process[1]. Accordingly, Canadian EAs are beginning to take cultural impacts seriously.

The recent and increasing focus on the cultural impacts of resource development represents a serious challenge to the EA practitioner. The purpose of this paper is to provide EA practitioners with an understanding of cultural impact assessment, key methodological challenges, and promising methods of assessment. Prior to this discussion, the paper begins with a brief review of how culture has historically been addressed in Canadian EAs undergoing review by joint panel.

[1] A series of Canadian legal decisions have determined that the Canadian Crown (provincial and federal governments) has the duty to consult and, where necessary, accommodate Aboriginal groups when it contemplates actions or decisions that have the potential to adversely affect an Aboriginal group's Aboriginal or Treaty rights.

CULTURE IN CANADIAN ENVIRONMENTAL IMPACT ASSESSMENT

Based on a review of joint panel assessment reports[2] produced for 32 Canadian EAs undertaken between 1996 and 2014[3], it is apparent that EAs were not required to rigorously assess the cultural impacts of resource development prior to the enactment of CEAA, 2012. Out of 28 EAs undertaken prior to 2012, 11 EAs contain no mention of indigenous culture. Of the 17 EAs that do recognize a potential for cultural impacts, the majority (9 EAs) are narrowly focussed primarily on impacts on 'cultural resources,' or physical sites holding cultural significance. For example, in response to indigenous concerns about the Lower Churchill Hydroelectric Generation Project's potential impacts on indigenous culture – including impacts on cultural landscapes, spiritual sites, way of life, cultural transmission, traditions and identity – the joint panel recommended implementation of commemorative initiatives for lost sites (such as installation of plaques and storyboards; Joint Review Panel 2011).

Several assessment review reports suggest that cultural impacts should be addressed outside of the EA process. For example, the joint panel for the Kearl Oil Sands Project in Alberta states that it is satisfied with the Proponent's commitments to "work with" indigenous groups to address their concerns about cultural impacts. Other joint panel assessment review reports suggest that cultural impacts are beyond the scope of the EA and proponent or government responsibility. For example, the joint panel for the Mackenzie Gas Project in the Northwest Territories concluded that "the primary responsibility for protecting and maintaining traditional language and culture rests with Aboriginal organizations and communities" (Joint Review Panel 2007: 529).

Another strategy undertaken by proponents and joint panels is to relegate cultural impacts to the sphere of socio-economics and consider them under an instrumental logic (King 1998). For example, despite recognizing statements by indigenous peoples that the traditional economy is more than a means of physical sustenance and includes spiritual and cultural values, the joint panel for the NWT Diamonds Project accepted the proponent's employee rotation schedule as adequate mitigation (Joint Review Panel 1996). Similarly, while the joint panel for the Voisey's Bay Mine and Mill Project in Newfoundland acknowledged the project's potential cultural impacts, it reasoned that the project's economic benefits would be sufficient compensation for indigenous peoples' cultural losses (Joint Review Panel 1997).

In contrast to the projects reviewed above, joint panel reviews of projects assessed pursuant to CEAA 2012 are starting to take culture seriously. For example, in response to the New Prosperity Gold-Copper Mine Project's argument that it had mitigated impacts to culturally significant sites (through avoidance, maintenance of access and relocation), and that the panel does not have the

[2] A joint review panel consists of a group of independent experts appointed by the Minister of the Environment, in cooperation with another jurisdiction, to conduct an environmental assessment. The Minister of the Environment may refer an environmental assessment to a review panel if the Minister is of the opinion that it is in the public interest to do so.

[3] The review consisted of searching assessment reports for the following terms: "culture", "cultural," "identity," "spiritual," "spirituality," "sacred," and "way of life."

authority to determine the "spiritual significance of a place," the panel found that the project would result in significant adverse effects on indigenous peoples' "ability to use the area for traditional activities, cultural and spiritual practices, intergenerational transfer of culture and knowledge, and traditional values" (Federal Review Panel 2013: 197). The project was rejected, largely due to its impacts on indigenous peoples' cultural practices which cannot be mitigated.

THE EMERGING FIELD OF CULTURAL IMPACT ASSESSMENT

Cultural Impact Assessment may be loosely defined as "a forward-looking tool that proactively assists decision-makers to mitigate or avoid negative effects, and enhance positive effects pertaining to: values and beliefs, ideas and ideologies, morals and manners, customs and traditions and other material and nonmaterial environments, or a combination of these" (Partel 2013). CIA is not yet an established field of practice in Canada or internationally, either as stand-alone assessments or as part of environmental impact assessments (Partel and Dunphy 2016). Within North America, cultural impacts, where considered, have generally been subsumed into archaeological assessments or social impact assessments, often resulting in significant gaps relating to intangible cultural elements (Nissley 2016). Internationally, there have been some attempts to codify CIA (e.g., Sagnia 2004), but there remains little consistency in the definition, methodologies, or processes for undertaking a CIA (Chetham 2010). There are currently no well-developed or accepted CIA measures or indicators (Partel and Dunphy 2016).

Increasingly, CIAs are prepared as part of EAs of resource development projects in Canada, either by project proponents (Golder Associates 2012), or, more commonly, by indigenous groups themselves (e.g., Candler, Gibson, and Malone 2015). However, these CIAs vary widely with respect to their approach, quality and methods, and little guidance is currently available to undertake or evaluate CIAs (although see Mackenzie Valley Review Board 2009).

Surprisingly, the emerging field of CIA does not draw on cognate fields of study. A large body of literature and practice has developed to describe and protect intangible cultural heritage (Vecco 2010), much of which is germane to the conceptualization and assessment of cultural impacts. Another body of literature that bears on CIA is the growing field of cultural ecosystem services (Milcu et al. 2013). Cultural ecosystem services research provides useful concepts, methods and indicators for the study of cultural and spiritual values (e.g., Chan et al. 2011).

A number of concepts can be derived from the testimony provided by indigenous peoples to EA joint panel and the few examples of Canadian CIAs, as well as the CIA, cultural heritage and cultural ecosystem services literature cited above. Key concepts include:

- **identity**: the sense of belonging to a unique collective;
- **sense of place**: the experience of attachment to particular places, based on shared sensory experiences, memories and stories;
- **sense of community**: social networks, shared values, roles, norms of reciprocity and participation in collective events and activities;

- **spirituality and ceremony**: the sense of connection to a wider force which may provide individuals with special powers and responsibilities;
- **governance**: the ability to engage in decision-making for collective welfare;
- **stewardship**: rules regarding resource management;
- **language**: legends, stories, place names and instruction used to encode and transmit culture;
- **traditional knowledge**: knowledge about the land and skills passed through generations;
- **livelihood**: means of sustenance and economy; and
- **cultural continuity**: the ability to engage in the same activities in the same places as ancestors did and to pass those skills and knowledges down to future generations.

Each of these concepts can be further articulated in relation to the research literature, operationalized and assigned with indicators with which to compile baseline information and assess potential impacts. However, there are a number of methodological challenges that CIA practitioners must be aware of before designing a study.

METHODOLOGICAL CHALLENGES

The primary methodological challenge for CIA is the intangible nature of cultural impacts (Chan et al. 2011). How is the practitioner to classify and measure impacts on such seemingly ephemeral things as identity, language, and sense of place? Training in social scientific methods is a necessary prerequisite for undertaking CIA (McCormack 2016). Methods such as ethnography, interviews, focus groups, grounded theory, and constructed scales have been specifically designed to qualitatively draw out and evaluate meanings, values, beliefs, and identities (Satterfield 2013). Other methods developed in the environmental social sciences may also be applied, such as multi-attribute utility theory, scenario analysis, and structured decision making (e.g., Gregory and Trousdale 2009). Whatever methods are used, it is essential they are deployed in a participatory manner with the cultures that have the potential to experience impacts. One promising approach to identifying and measuring human values with respect to ecosystems is participatory mapping exercises (Brown and Fagerholm 2015).

A second methodological challenge is the interdependency and multi-causality of cultural impacts (Satz et al. 2013). It can be very challenging to disentangle the various attributes of culture and the places and experiences with which they are associated. For example, knowledge transmission may be performed via stories recounted while undertaking livelihood practises in locations used by ancestors, thereby reinforcing identity, spiritual connection and sense of place. This presents a serious methodological challenge, as it can result in 'double counting', whereby an effect on a cultural attribute is registered for more than one category of culture being assessed (e.g. an effect on identity is identified both with respect to changes to knowledge transmission and sense of place) (Chan et al. 2011). The primary solution to this problem is to be very specific about the effects being assessed and the causal pathways involved, and to derive conclusions only for the final cultural attribute in a chain of attributes (Satz et al. 2013).

A third methodological challenge relates to the difficulty of integrating the CIA into the wider EA. Environmental assessments of natural resource projects address multiple human and nonhuman components using a common methodology. Generally, EA methodology includes characterizing residual effects (i.e., effects remaining after the application of mitigation measures) on the basis of criteria such as magnitude, extent, frequency, duration, and reversibility. The significance of effects are determined on the basis of these rankings, ideally in relation to established thresholds. This rigorous and highly valuable approach was based on principles derived from the science of ecology (Beanlands and Duinker 1983), which tends toward reductionism and quantification. This approach sits uneasily with CIA, which deals with qualitative data and narrative. However, this does not entail that cultural impacts are incommensurable with more easily quantified impacts. As noted by Satz et al. (2013), and as demonstrated by Satterfield (2013), it is possible to partially order and rank cultural values in ways that are amenable to comparison with conclusions derived from quantitative data sets.

CONCLUSION

Canadian environmental impact assessment is beginning to take cultural impacts seriously. This development must come as welcome news to indigenous people, who have consistently raised concerns about the impacts of natural resource development on their identities, spirituality and way of life. The focus on cultural impacts creates serious challenges for proponents and EA practitioners, however. This paper has sought to demonstrate that these challenges, while substantial, are not insurmountable. When informed by strong participatory social scientific methods, cultural impacts can be rigorously assessed and integrated into the EA process.

REFERENCES

Angell, A. and J. Parkins. 2011. Resource development and aboriginal culture in the Canadian north. *Polar Record*, 47 (240): 67-79.

Beanlands, G. E. and P. N. Duinker. 1983. *An Ecological Framework for Environmental Impact Assessment in Canada*. Institute for Resource and Environmental Studies, Dalhousie University: Halifax, Nova Scotia.

Brown, G. and N. Fagerholm. 2015. Empirical PPGIS/PGIS mapping of ecosystem services: A review and evaluation. *Ecosystem Services*, 13: 119-33.

Candler, C., G. Gibson, and M. Malone. 2015. *Wîyôw'tan'kitaskino (Our Land is Rich) A Mikisew Cree Culture and Rights Assessment for the Proposed Teck Frontier Project Update*. The Firelight Group Research Cooperative: Victoria, BC.

Chan, K., J. Goldstein, T. Satterfield, N. Hannahs, K. Kikiloi, R. Naidoo, N. Vadeboncouer, and U. Woodside. 2011. Cultural services and non-use values. In *Natural Capital: Theory & Practice of Mapping Ecosystem Services*. Ed. P. Kareiva, Tallis, H., Ricketts, T.H., Daily, G.C., Polasky, S. 206–28. Oxford, UK: Oxford University Press.

Chetham, J. 2010. *Best practice guidelines: Tangata Whenua effects assessment - a roadmap for undertaking a Cultural Impact Assessment under HSNO 1996*. Repo Consultancy Ltd.: Whangarei, New Zealand.

Federal Review Panel. 2013. *Report of the Federal Review Panel: New Prosperity Gold-Copper Mine Project, Taseko Mines Ltd.* CEAA Reference No. 63928. Federal Minister of the Environment: British Columbia.

Gibson, R. 2012. In full retreat: the Canadian government's new environmental assessment law undoes decades of progress. *Impact Assessment and Projet Appraisal*, 30 (3): 179-88.

Golder Associates. 2012. *SIR 30 - Cultural Assessment*. Prepared for Shell Canada Limited's Proposed Jackpine Mine Expansion Project:

Gregory, R. and W. Trousdale. 2009. Compensating aboriginal cultural losses: An alternative approach to assessing environmental damages. *Journal of Environmental Management*, 90 (8): 2469-79.

Joint Review Panel. 1996. *Federal Environmental Assessment and Review Process NWT Diamond Project Canada: Report of the Environmental Assessment Panel*. Minister of Supply and Services Canada: Hull, Quebec.

Joint Review Panel. 1997. *Voisey's Bay Mine and Mill Environmental Assessment Panel Report*. Minister of Supply and Services Canada: Labrador and Newfoundland.

Joint Review Panel. 2007. *Report of the Joint Review Panel Established by the Alberta Energy and Utilities Board and the Government of Canada EUB Decision 2007-013: Imperial Oil Resources Ventures Limited, Application for an Oil Sands Mine and Bitumen Processing Facility (Kearl Oil Sands Project) in the Fort McMurray Area*. EUB Decision 2007-013. Alberta Energy and Utilities Board and Canadian Environmental Assessment Agency: Fort McMurray, Alberta.

Joint Review Panel. 2011. *Report of the Joint Review Panel: Lower Churchill Hydroelectric Generation Project, Nalcor Energy*. CEAA Reference No. 07-05-26178. Minister of Environment, Government of Canada: Newfoundland and Labrador.

King, T. 1998. How the archaeologists stole culture: a gap in American environmental impact assessment practice and how to fill it. *Environmental Impact Assessment Review*, 18: 117-33.

Mackenzie Valley Review Board. 2009. *Status report and information circular - developing cultural impact assessment guidelines*. http://www.reviewboard.ca/reference_material/cultural_impact_assessment.php (accessed October 2015).

McCormack, P. 2016. Doing Credible Cultural Assessment: Applied Social Science. *Environmental Practice*, 18 (3): 148–65.

Milcu, A., J. Hanspach, D. Abson, and J. Fischer. 2013. Cultural Ecosystem Services: A Literature Review and Prospects for Future Research. *Ecology and Society*, 18 (3): 44.

Nissley, C. 2016. Integrating Cultural Impact Assessments into Environmental Analysis. *Environmental Practice*, 18 (3): 222-26.

Partel, A. 2013. *Impact Assessment: A Tool to Assist Cultural Sustainable Development*. Paper presented at People and the Planet 2013 Conference: Transforming the Future, RMIT University, Melbourne, Australia: Global Cities Research Institute, RMIT University, Melbourne, Australia.

Partel, A. and K. Dunphy. 2016. Cultural impact assessment: a literature review of current practice around the world. *Impact Assessment and Project Appraisal*, 34 (1): 1-13.

Sagnia, B. 2004. *Framework for cultural impact assessment*. International Network for Cultural Diversity (INCD): Cultural Impact Assessment Project: Dakar, Senegal.

Satterfield, T. 2013. Culture, intangibles and metrics in environmental management. *Journal of Environmental Management*, 117: 103-14.

Satz, D., R. Gould, K. Chan, A. Guerry, B. Norton, T. Satterfield, B. Halpern, J. Levine, U. Woodside, N. Hannahs, X. Basurto, and S. Klain. 2013. The Challenges of Incorporating Cultural Ecosystem Services into Environmental Assessment. *Ambio*, 42: 675-84.

Vecco, M. 2010. A definition of cultural heritage: From the tangible to the intangible. *Journal of Cultural Heritage*, 11: 321-24.

Sami people: natural resources and climate change

Ezequiel Pinto-Guillaume, archaeologist, *WSP Sweden*

The Sami people are strongly dependent on available natural resources. Therefore, it seems important to consider how they perceive their natural resources and climate change when working with assessments.

How vulnerable are the Sami people to risks connected to climate change? Their entire way of life is strongly connected to the surrounding natural environment. For centuries, they have endured the severe policies of the Scandinavian states alongside the harsh Arctic environment. The Sami have adapted, persevered and survived. Climate change is a new threat, which seems to give them fewer possibilities to adapt.

Do the Sami people perceive the effects of climate change differently to us in the Western world? They have a relational worldview, very different to ours. I suggest that it is necessary to understand this difference during assessment work. This paper will look into how the Sami people perceive their natural resources and the effects of climate change as well as trying to distinguish the vulnerability of Sami to risks associated with climate change.

The Sami people

The Sami are an indigenous people of Northern Europe who live today in a cultural region, which stretches across the northern parts of Norway, Sweden, Finland and Russia (see Fig. 1). They choose to call the Sámi traditional homeland "*Sápmi*" (Gaski 1993, p. 115; Kailo & Helander 1998, p. 17). In Sweden, Sápmi covers between 35% and 50% of the total land area (Sametinget 2004; Svonni 2011). The oldest historical documents available provide evidence of Sami inhabiting the northern part of the geographical region of Fennoscandia (cf. Uddenberg 2000, p. 13).

We know little about the Sami people's history before the old Swedish name *Lappmarken*, a denomination for Northern part of the old Kingdom of Sweden, appears in a letter by Swedish King Magnus Eriksson in 1340. When the Swedish state began to build up during the 16th and 17th centuries, the Sami found themselves at the borders of this society.

Figure 1. Map of Fennoscandia showing the geographical extension of Sápmi

Reindeer and the Sami have ancient bonds with each other. This relationship has been constant for thousands of years. In the beginning the reindeer were essentially prey for the hunting Sami, who also domesticated some as draft animals or for milking. Towards the end of the 16th century, the Sami shifted from wild reindeer hunting to domesticated reindeer herding. The combination of a growing Sami population with more intensive state taxation pushed the old hunter society to become shepherds. The Sami, who had been relatively sedentary, became nomadic shepherds within the landscape (Svonni 1976, p. 9; Uddenberg 2000, p. 16). The phenomenon of large reindeer herds that we associate with Sami lifestyles nowadays are actually only about four hundred years old.

Background: Sami pre-Christian religion

Pre-Christian Sami religion retained its significance well into the 18th century, until the true colonization of Sápmi began (Michael 2014, p. 3). Our knowledge of the origins of the Sami religion is incomplete. The little we know comes from unbiased missionary priests'

descriptions. As Christian representatives, these priests distanced themselves from other worshipping and shamanism. Correspondingly, the Sami concealed parts of their cult from priests and other non-Sami people. It was easier to practice their religion in silence and thus avoid trouble with the state authorities (Uddenberg 2000, p. 33).

Figure 2. Group photo of Sami from Sorsele. Photo: Lotten von Düben, No Copyright, Wikimedia

Sami philosophy and worldview

There is a close relationship between the concepts of "philosophy" and "worldview". Considering "a philosophy" in its broadest sense denotes a worldview. This is the case when we speak about the philosophy of the Sami people. People have diverse concepts and diverse ways of perceiving the world. Worldview consists of the central assumptions, concepts and premises which a specific group of people shares and upon which they base their activities. Every behaviour or ideology has its own purposes and functions (cf. CoE 2009, p. 29; Vidal 2008, p. 3). These originate from personal or community needs.

Worldview is the basis of all aspects of human life that influences specific cultural and life structures as well as religious beliefs. The Sami structure their worldview around the elements and phenomena of their natural environment. They believe that all living things and natural elements - which other cultures may not even consider alive such as rocks and mountains - have a connection to one another.

Sami people's belief system and their environment

In anthropology, the religious belief that various objects, places, and creatures possess distinctive spiritual qualities is described as animism. It is the oldest known type of belief system in the world. Many traditional societies still practice it in a variety of forms.

In Sámi belief, animism is manifested in the belief that all significant natural objects (such as animals, plants and rocks) possess a soul and, from a polytheistic perspective, traditional Sámi beliefs include a multitude of spirits. When animism is the dominant belief system, human norms and values have to take into consideration the outlook and the interests of a multitude of other beings, such as animals, plants and these spirits (cf. Harari 2015, p. 235). In order to survive in their harsh environment the Sami needed and still need to understand the superhuman order that regulates their environment and to adjust their behavior accordingly.

Studies show that modern Swedes perceive nature as a source of sensory experience and recreation. To them, nature appears "wild" and relatively untouched by man (Uddenberg 1995). The Sami, however, perceive nature as a religious experience. They describe nature in terms of relatedness, where each organism has its place and plays a particular role. Nature's ideal condition, its "balance", should be respected; therefore, a practical consequence is that any engagement with nature should be as minimal as possible (Uddenberg 2000, p. 142).

Climate change and the Sami people

The Sami are very concerned about climate change and even more concerned with being heard by the governing authorities on this matter. Nature in the Arctic region is fragile; therefore, climate change threatens to upset the natural balance of the region. A shift in the arctic tree line, pushing it further north as well as the introduction of invasive species, will undoubtedly affect the flora, fauna and, consequently, the traditional use of nature in the area (Keva 2015).

Back in the 1990s when the subject of climate change was becoming a common topic, Sami reindeer herders were noticing anomalies in the season's cycle. Because of this, they made some changes in their herding methods (Pasotti 2016). Reindeer herding activities are important for other species in the fell areas. When the reindeer leaves an area, the grouse arrives, followed by small rodents and soon after that the fox (Kihlberg 2016). Within the ecosystem, everything is connected.

Sami vulnerability to climate change

Indigenous peoples are particularly vulnerable to the impact of climate change. Nature, economy and culture are strongly linked in Sami society. They have relied for centuries on a long-term ecological vision, which is based on a respect for nature, their source of living.

History shows that the Sami are a resilient people. Those who practice reindeer herding have acquired the ability to be mobile and disperse over large areas. They are flexible, something which is crucial in adaptation (Tennent 2015). Thus, probably their greatest obstacle is adapting not to climate but to politics (Keva 2015). Indigenous peoples have limited opportunities to influence policy and decisions on land use issues.

The Sami people can draw on the utmost detailed knowledge about weather conditions and available natural resources. They have an ethical relationship with nature (Tisdall 2010). The Sami have solutions to climate change adaptation, but their ideas seldom reach the appropriate political or scientific spheres. Their solutions rely on having access to the land and being able to apply their traditional knowledge in a more flexible manner (cf. Pasotti 2016).

Concluding observations

The Sami people have a deep relationship with nature, which is hard to capture in words. They have a living approach towards the surrounding environment in which each organism has its place and a particular function. Nature's ideal condition, its "balance", should be maintained. Thus, great parts of the Sami value foundations are strongly connected to a life in direct contact with nature.

The Sami people possess a local and traditional knowledge, which is a vital resource in confronting climate change. Sami people are also vulnerable to risks connected to climate change; however, they are also resilient, flexible and have a solid ethical relationship with nature. The problem is that governments continue to reject the idea that indigenous peoples have something useful to say on the subject.

As an analogy, when working with an assessment within Sápmi, it is inappropriate and misleading to proceed from an exclusively westernized point of view. The same applies to coping with climate change in the Sápmi region. Not taking into consideration Sami traditional knowledge in the process only makes it more difficult to arrive at a solution.

References

CoE 2009, *Council of Europe, Human rights education in the school systems of Europe, Central Asia and North America: a compendium of good practice*, Warsaw OSCE Office for Democratic Institutions and Human Rights (ODIHR) 2009.

Gaski 1993. Gaski, Harald, "The Sami People: the 'White Indians' of Scandinavia", *American Indian Culture and Research Journal* 17(1), 1993, p. 115-128.

Harari 2015. Harari, Yuval Noah, *Sapiens: a brief history of mankind*. London, Vintage books, 2015.

Kailo & Helander 1998. Kailo, Kaarina and Helander, Elina "The Sami People", in K. Kailo & E. Helander (eds.), *No beginning, no end: the Sami speak up*, Canadian Circumpolar Institute, Edmonton, 1998.

Keva 2015. Keva, Juho. "Arctic Indigenous People and Climate Change" in Is Climate Change Destroying Indigenous Peoples (International seminar), Siemenpuu Foundation, Helsinki, 30 Oct. 2005.

Kihlberg 2016. Kihlberg, Jannike, "Renarna drabbas redan av förändrat klimat", *Dagens Nyheter*, 27 Dec 2016.

Michael 2014. Michael, Nina, "Översikt över Sameland (Sápmi)", Tidningen Kulturen, online at: http://tidningenkulturen.se/index.php/mer/debatt/119-samhe/17603-oeversikt-oever-sameland-sapmi, published 3 June 2014 (accessed 7 Jan. 2015).

Pasotti 2016, Pasotti, Jacopo, "El camino de los Sami hacia el cambio", *El Pais*, 9 Nov. 2016.

Sametinget 2004. *Samer: ett ursprungsfolk i Sverige*, Kiruna, Sametinget, 2004, online at: http://www.samer.se/2136, last updated 25 Jan 2005 (accessed 12 Jan. 2016).

Svonni 2011. Svonni, Ragnhild, *Siellu min siste – Landskapet inom oss*, Riksantikvarieämbetet, online at: https://www.youtube.com/watch?v=r0zWEoK5JUQ, uploaded 27 Nov. 2011 (accessed: 26 May 2015).

Tennent 2015, Tennent, James, "COP21: How climate change is destroying the Sami way of life in Scandinavia", *International Business Times*, 31 Oct 2015.

Tisdall 2010, Tisdall, Simon, "What the Sami people can teach us about adapting to climate change", *The Guardian*, 10 Mar 2010.

Uddenberg 1995. Uddenberg, Nils, *Det stora sammanhanget*, Nora: Nya Doxa, 1995.

Uddenberg 2000. Uddenberg, Nils, *Renarna, markerna och människorna: om svenska samers syn på natur, djur och miljö*. Nora: Nya Doxa, 2000.

Vidal 2008. Vidal, Clément Wat is een wereldbeeld? (What is a worldview?), in Van Belle, H. &Van der Veken, J., Editors, Nieuwheid denken. De wetenschappen en het creatieve aspect van de werkelijkheid, in press. Acco, Leuven, 2008.

SEA of the inclusion of renewable energies

PIRILLO, Ernesto; **DOMINGUEZ,** Santiago; **FAZIO**, Leandro; **ROMANELLI**, Martín y **STRANO** Franco.
Center for Environmental Studies (CESAM) – Faculty of Engineering – Universidad de Buenos Aires (UBA) – ARGENTINA.

ernestopirillo@yahoo.com.ar; santiago.dominguez@hotmail.com; leandrofazio_88@hotmail.com; martinromanelli1990@hotmail.com; franco.strano.1991@gmail.com

ABSTRACT

A strong dependence of fossil fuels characterizes the electrical argentine sector. In recent years, have verified some progress in relation to the introduction of energy from renewable sources by changing the legal framework, subsidies for research, product development, etc. although it is still far from being an important sector within the matrix. As part of a SEA for the inclusion of renewable energies into the matrix, this paper includes significant information and set of data for each of the natural resources and their potential for energy production throughout the country: thermal solar, photovoltaic solar, wind power, biomass, mini hydraulic and wave energies. Finally, it presents an analysis for implementation of the various technological options and some environmental impacts.

Summary Statement: This paper discuss the possibility of introducing renewable energy into the matrix by including data for each natural resource and its potential for energy production in some ecoregions of Argentina.

Key words: electric energy, renewable energies, environmental strategic assessment (SEA)

1. INTRODUCTION

1.1. Electrical Argentinian System

A strong dependence of fossil fuels characterizes the electrical argentinian system. Until July, 2016 the power (equipment) installed in the Argentinian System of Interconnection (SADI) has been little diversified. Three big groups can be distinguished, in agreement to the natural resource and to the technology that they use: Thermal Fossil with 60.08 %, Hydraulic with 33.96 % being the principal skeleton that supports the functioning of the Electrical National System. The Nuclear technology contributes 5,36 % and between Wind and Photovoltaic energies do not reach 1 % of the total. (Fig.1)

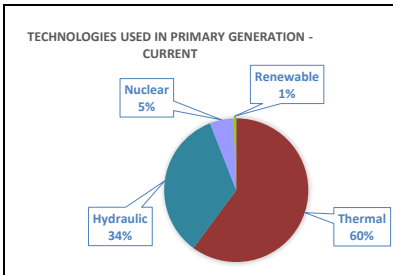


Figure 1: Current technologies used in primary generation

The Thermal Fossil sector, in turn, can be subdivided into four classes, in agreement with the type of thermal cycle that they use to take advantage of the energy: steam turbine, gas turbine, combined cycle, and diesel engines.

The poor incidence of the renewable energies is very distant from the aims raised by the Law 27.191, sanctioned in September 2015, which fixes as targets that national electricity company reaches an 8 % of the energy consumption to 12/31/17 and a 20 % on December 31st, 2025.

1.2. Argentinian System of Interconnection (SADI)[1]

The electrical system is shaped by generating factories of electricity, electrical lines of discharge and extra high tension, electrical networks of distribution and by diverse consumers of electricity (residential, industrial and commercial). This system does not store electrical energy, which means that at all times the generation must be equal to the demand or consumption of the market, making necessary the export of the surplus.

[1] Previously denominated National Interconnected System – "Sistema Interconectado Nacional (SIN)"

All the elements and facilities of transmission, compensation and maneuver integrate what is known as Argentinian System of Interconnection (SADI), shaped by the High Voltage Transport System and for the Systems of Transport for Main Distribution of the different electrical regions of the country. The equipment installed in the SADI commercializes its generation of energy on the Electrical Wholesale Market (MEM) being administered by CAMMESA (Wholesale Electrical Market Management Company).

1.3. Greenhouse Gases (GHG)

Figure 2 shows the evolution of the electricity generation by technology, where the strong dependence on fossil fuels is observed. Obviously, the increase of the GHG accompanied the evolution. Within the fossil fuels, the principal generator is the Natural Gas (GN). The utilization, from 2010 of Generators of Combined Cycle, using as fuel, mainly fuel oil and diesel oil, has taking place the increase in the last years. Though the emission of GHG related to the electrical Argentine sector is scarcely 0,6 % of the world total of this sector, it will be necessary to realize efforts locally to comply with global targets.

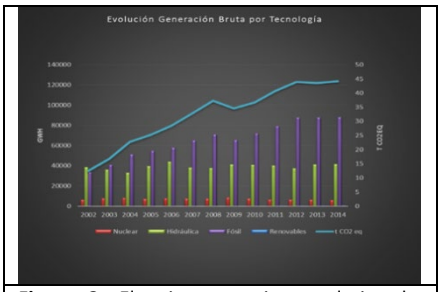


Figure 2: Electric generation evolution by technologies (nuclear-hydraulic-thermal fossil-renewables-t CO_2 eq) CAMMESA. 2014

1.4. Strategic Environmental Assessment (SEA)

Strategic Environmental Assessment: Due to the conformation and evolution of the SADI, it is considered indispensable to evaluate, from an environmental and strategic point of view, the modification of the energetic matrix of the next years, taking into account, apart from the incorporation of new renewable sources of generation, the introduction of the distributed generation system.

The scope of present SEA will be national. The Strategic Environmental Diagnosis will be carried out through the conformation of homogeneous regions, taking into account specific indicators.

The area in which the present SEA is developed is the academic level and it includes stages of participation and consultation with the directly involved sectors, whether from the private or official sector.

Stages: First stage presented in the present work. In the second stage (not included here), we will have analyze the economic, labor and tariff impact, especially regarding distributed generation.

1.5. Distribuited Generation

The impact of renewable energy sources on electricity generation is due to large-scale forms of generation (solar farms, wind parks, etc.), called "centralized generation" also on a small-scale (solar residential facilities, low power wind turbines, etc.), called "distributed generation".

Typically, the first one develops in places far from the points of consumption while the second one develops in places closer to them, being a particular case the "microgeneration" where the generation is located exactly in the points of consumption.

Government policies of promoting the utilization of renewable energy sources, likewise, can be directed towards one or another form of generation.

1.6. Regulatory Frame

The current Argentinian National Electricity Regulatory Framework is based on Law 15.336 of September 1960 and its complement, Law 24.065 of January 1992. Both laws establish the general regulatory aspects for all activities within the electricity sector but by themselves are not a sufficient tool for the development of electrical power generation from renewable sources.

In Argentina, the SEA management tool is not regulated. The only antecedent of specific legislation is in the City of Buenos Aires, even as a project law.

With regard to the regulations concerning Distributed Generation, began in 2013, in the Province of Santa Fe. Nowadays, six provinces have sanction specific regulatory framework.

2. METHODOLOGY

2.1 Selection of the spaces of implementation

The Argentinian territory presents a great diversity of environments with generate an important heterogeneity in the climatological characteristics. This, added to the cultural diversity of every region, influences directly the customs of the inhabitants, which define a level of activity that is reflected in the residential electricity demand.

The current regionalization of Argentina is based principally on administrative and economic factors. Therefore, a division will be carried out bearing parameters specially selected and correlated directly with the aim of this work.

The selection of the parameters used for the formation of the conglomerates have tried to include different related aspects, directly or indirectly, with the utilization of the natural resources as source of energy (Table 1).

Table 1: selected parameters for regionalization

PARAMETERS	
ECONOMIC AND SOCIAL	Per capita mounthly income
	Annual electricity consumption
ENERGETIC	Average annual radiation energy
	Annual wind power
CLIMATIC	Average annual temperature
	Average annual precipitation
	Annual potencial evapotranspiration

In order to avoid the overlapping effect, we made a previous analysis of principal components that reduced the quantity of variables. Later, the Cluster Analysis in strict sense was made and the proposed regionalization was obtained (Figures 3).

For Statistical Analysis, corresponding software InfoStat 2016 has been used.

2.2 Energetic Potential

Solar Potential: Radiation and heliophania data were collected for each province from the Atlas of Solar Power (Rossi and Righini, 2007 and INTA, 2010). Then, an average was obtained between the values of summer and winter and, the theoretical average power per province have been from the area of each province. In this stage, 0,1% of each zone have been considered in order to calculate the generated possible energy.
Wind potential: has been considered to be equal or superior winds to 6.5 m/s, turbines of 2 MW and distributed in 0,1 for every km^2. (Mapa Nacional Eólico, 2009).
Wave potential: The principal parameters taken into account are the surface of submarine platform up to 350 miles from the Argentinian land coast, with a total of 2.821.103 km^2, waves between 2 to 2,25 m. of height in average and the devices Pelamos P-750 for the receipt of this energy. (Mapa Mundial Energético Undimotriz, 1991).
Minihydroelectric potential: For the calculation of the theoretical power, projects smaller than 30 MW were considered and those mini hydroelectric power stations that are in operation or out of service. (PROINSA, 2016). For the possible power, the 116 mini plants that are in project state have been analyzed.
Biomass Potential: In the case of biomass, it is separated into the five possible sources of the resource: livestock biomass, agricultural, urban solid waste, sewage effluents, and wood energy. (FAO, 2016. Charpentier, 2014, INTA, 2013, 2011. SENASA, 2014).

3. RESULTS AND DISCUSSION

3.1 Spaces of Implementation

The selection of the implementation spaces yielded the results shown in figure 3.
The following table 2 shows the general potential for electricity generation from renewable sources.

Región	Provincia
Boreal	Chaco
	Stgo. del Estero
	Santa Fe
	Formosa
	Misiones
	Corrientes
	EntreRíos
	Salta
	Tucumán
Poniente	Jujuy
	Catamarca
	La Rioja
	San Juan
	Mendoza
Naciente	Buenos Aires
	Córdoba
	La Pampa
	San Luis
	Río Negro
	Neuquén
Austral	Chubut
	Santa Cruz
	Tierra del Fuego

Figure 3: Space of Implementation

Table 2: Theoretical power, possible power and electric generation

RESOURCE	ZONE	THEORETICAL POWER (GW)	POSSIBLE POWER MW	GENERATION GWh/ annual
SOLAR	1	307.629	67.678	180.315
	2	531.794	116.995	274.594
	3	590.752	129.965	305.476
	4	281.709	61.976	113.641
TOTAL SOLAR		**1.711.884**	**376.614**	**874.025**
WIND	1	-	-	-
	2	-	-	-
	3	632	31.590	270.730
	4	1.139	56.945	488.015
TOTAL WIND		**1.771**	**88.535**	**758.745**
BIOMASS	1	1,92	1.498,10	10.499
	2	11,21	10.060,70	70.505
	3	6,57	4.480,30	31.398
	4	1,55	1.104,50	7.740
TOTAL BIOMASS		**21,26**	**17.144**	**120.142**
BIOMASS FROM USW	1	0,02	4,30	30,13
	2	0,05	18,30	128,25
	3	0,10	73,90	517,89
	4	0,00	1,80	12,61
TOTAL BIOMASS USW		**0,16**	**98,30**	**688,89**
MINI HYDRAULIC	1	0,23	126,20	482,09
	2	0,28	134,76	668,11
	3	0,24	117,76	357,94
	4	0,12	55,68	265,59
TOTAL HYDRAULIC		**0,87**	**434,40**	**1.773,74**
WAVES	1	-	-	-
	2	-	-	-
	3	704510	35226	61715
	4	1539355	76968	134848
TOTAL WAVES		**2.243.866**	**112.193**	**196.563**
TOTALS		**3.957.543**	**595.019**	**1.951.938**

In a first analysis, using very conservative indexes (e.g. in the case of PV solar energy production) it can be observed that the potential of renewable energies is enormous. For example, the possible potential is 1818 % higher than the installed current power and the generation of corresponding energy is more than eight times the current one (732 %). The most important of the resources in terms of magnitude of installed power is the wind one, even with the extreme restrictions imposed to the analysis.

Table 3: some results from the previous potentialities obtained.

Installed potency 2015 (CAMMESA)	32.729	MW
Possible potency	595.019	MW
Relationship possible / current installed	**1.818,02**	**%**
Maximun demand 2015	266.550	GWh
Possible generation	1.951.938	
Relationship possible / current	**732,30**	**%**
Solar + Wind 2015	195	MW
Solar + Wind possible	465.149	MW
Relationship possible / current	**238.538**	**%**
tCO2eq/GWh generation by CC and natural gas	726.120.913	t CO2eq
tCO2/GWh generation by Renewable energies	167.399	t CO2eq
Saving	**725.953.514**	**t CO2eq**

We can also highlight that the zone most benefited by the energetic resources would be zone 4, located to the south of the country, with a 744,522 GWh of potential generation of electrical power, the majority being from wind resource. In this way, there would be a saving of 726 million tCO_2eq compared to what the current matrix would produce, mainly thermal. (Table 3).

3.2 Alternatives scenarios

In Argentina's energetical scenarios by 2035 (Fernandez, 2015) organizations representing the country's technical and academic sectors, two scenarios of Electrical Demand Projection have been proposed.

- “Business as Usual (BAU)” projection: demand growth by 3.4% per annum
- "Rational Use of Energy" (ERU) Projection: demand growth by 1.9% per year

In the BAU scenario, demand for electrical power has been estimated by 251,040 GWh in the year 2035. The total installed power required to supply the above demand is estimated at 73.1 GW by the year 2035 (average load factor of 70 %), implying an increase of 130%, associated with a growth rate of 3.9% per annum. The difference in favor of the URE is a saving demand for accumulated energy efficiency, by 20 % in 2035.

Regarding the UBA matrix proposal, made by the Energy and Environment Group of the Faculty of Engineering, due to the existence of multiple alternatives and technological combinations, the minimization of the cost of electricity energy has been established as a main objective.

It is possible to observe, that the notorious participation of the renewable energies corresponds to a decrease of the thermal option, fundamentally. (Figures 4 and 5)

Associated with the above, there are substantial improvements with respect to the production of Greenhouse Gases (GHG) and total emissions. (Fig. 6). Calculation process was carried out by the LEAP system (LEAP, 2012).

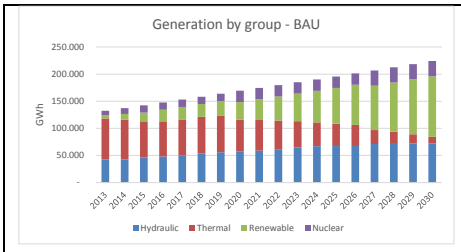


Figure 4: Electricity generation by technologic group, for the BAU scenario

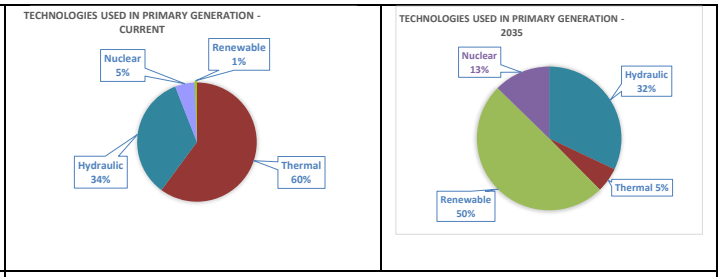


Figure 5: Electricity matrix. Actual situation and proposal for 2035

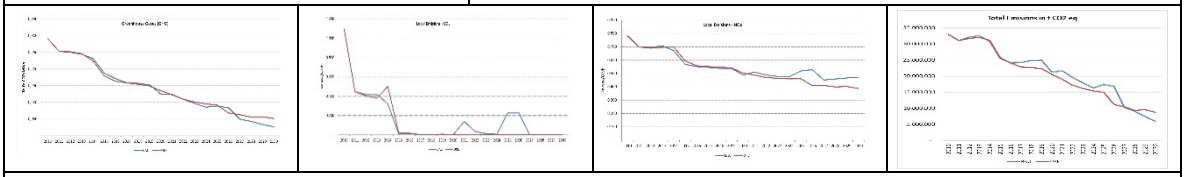


Figure 6: GHG, SO_2, NO_X emisions y total emisions in tCo_2eq associated with the new matrix proposed. www.escenariosenergeticos.org

4. CONCLUSIONS

The matrix for the generation of national electric energy is characterized by a strong dependence on fossil fuels. Lately, some progress have been made regarding the incorporation of renewable sources for electricity production, especially through the adjustment of the regulatory framework.

The analysis of the potential of the country for electricity generation from renewable sources strongly supports the proposal to modify the future energy matrix, contributing to diversification, decrease in GHG production and the non-dependence on natural gas.

In the next years, it will not only be necessary to change the composition of the energetic matrix, but also the generation and distribution models, by incorporating distributed generation and Smart Grids, in order to reduce transportation and distribution costs and improving the safety of the supply.

5. REFERENCES AND BIBLIOGRAPHY

CAMMESA, 2014. Distribución porcental de la potencia instalada en el SADI, al 30/06/2014.

Charpentier, J., 2014. Tratamiento de aguas residuales con lodos activados. INTI. Buenos Aires.

FAO, 2016. Proyecto para la promoción de la energía derivada de la biomasa. Ministerio de Minería y de Energía. Ministerio Agricultura, Ganadería y Pesca.

Fernandez Ramiro, 2015. Metodología para la Elaboración y Evaluación de Escenarios Energéticos. Plataforma de Escenarios Energéticos Argentina 2015-2035. www.escenariosenergeticos.org

FIUBA, 2011. Estudio de calidad de los residuos sólidos urbanos del área metropolitana de Buenos Aires.

INDEC (Instituto Nacional de Estadística y Censos), 2012. Censo Nacional de Población, Hogares y Viviendas 2010 y Encuesta Permanente de Hogares. (EPH) http://www.indec.gov.ar

INFOSTAT, 2016. Programa Estadístico. Versión actualizada día: 17-11-2016. Universidad Nacional de Córdoba. Argentina. www.infostat.com.ar

INTA, 2010. Programa Nacional de Ecorregiones. Mapa de Evapotranspiración Potencial Anual. Mapa Precipitación Media Anual. Mapa Temperatura Media Anual República Argentina. Atlas Climático Digital.

INTA, 2013. Cuantificación y uso de Biomasa de residuos de cultivos en Argentina para bioenergía. Buenos Aires

INTA, 2011. Escenario internacional y análisis de la actividad ganadera bovina nacional por estrato de productores y composición del stock 2011.

LEAP 2012. Long-range Energy Alternative Planning. Versión 2012.0.0.56.

Mapa Eólico Nacional a través del Sistema de Información Geográfico (SIG eólico). Ministerio de Energía y Minería de la República Argentina. http://sigeolico.minplan.gob.ar/frameset.php.

OETEC. 2014. Indicadores energéticos de la Argentina. http://www.oetec.org

Plan de Energías Renovables en España, 2005-2010. Factores de Emisión para Generación Eléctrica.

PROINSA; Secretaría de Energía, 2006. Estudio para mejorar el conocimiento y la promoción de oferta hidroeléctrica en pequeños aprovechamientos. Buenos Aires.

Rossi Gallegos Hugo y Raúl Righini, 2007. Atlas de Energía Solar de la República Argentina. Grupo de Estudios de la Radiación Solar (GERSolar). Universidad Nacional de Luján.

SENASA, 2014. Informe estadístico de la producción porcina . 2014.

Mapa Mundial Energético Undimotriz, 1991. Wave Energy paper. I Mech E. European Directory of Renewable Energies. En: Mafia del Castillo, Carlos, 2009. Tesis de Ingeniería Industrial Aplicabilidad de la Energía de los Océanos.

Air Pollution at Incinerator and Health Risk Assessment

Sukanda Pudpadee[1], Panita Charoensuk[2*], Wassana Loonsamrong[3], Nuttapon Sirilar[4]

[1, 2, 3, 4] Health Impact Assessment Division, Department of Health, Ministry of Public Health Thailand
[1]sukanda1212@yahoo.com, [2]n_atom90@hotmail.com, Loonsamrong.blue@gmail.com, n_sirilar@hotmail.com

Abstract
This study aimed to assess the health risk associated with the inhalation of air pollutants including VOCs and heavy metals for workers at waste incinerator site in the South of Thailand. Air samples were collected and analyzed followed by NIOSH standard method, air samples were collected for 8 hours continuously. The concentration of heavy metal; Hg, Cd, Pb, Mn, Ni were very low while mean concentrations of VOCs; benzene, toluene, ethylbenzene, xylenes, and styrene were determined as 0.080, <0.001, 0.031, 0.043, and <0.001 mg/m^3 respectively. Health risk assessment was employed to evaluate the carcinogenic and non-carcinogenic effects. The cancer risk for benzene exposure was estimated to be 1.26×10^{-5} that is higher than the acceptable risk level of 1×10^{-6}. Non-carcinogenic risk (Hazard Quotients; HQ) for toluene, ethylbenzene, xylenes and styrene was at acceptable level. Thus, workers in this plant were at risk to health effects associated with benzene via inhalation exposure. Health promotion and risk communication should be given to them in appropriated way.

Keywords : Waste Incinerator, Health Risk Assessment, Occupational Health, Air pollution

1. Introduction

Waste incinerator is one of solid waste management technology which has been gearing up in Thailand [1]. However, incomplete combustion is a cause of organic compound emission such as aldehydes, chlorinated hydrocarbons, PAHs, polychlorinated dibenzodioxins, dibenzofurans et.al, which is leading to environmental and health effects [2]. The previous studies have found that living within 3 kilometers from an incinerator plant indicates an increased risk of lymphoma and soft tissue sarcoma cancer up to 3.5% . More evidence is shown that living close to an incinerator has relation to respiratory disease [3-4]. In particular the incinerator related workers were exposed to particulates and heavy metals 10 to 100 folds greater than that of general population [5]. This study aimed to assess the health risk for the solid waste incinerator related workers.

2. Materials and Method

2.1 Study Area and Study Population

This study selected waste-to-energy plant in the Southern part of Thailand. Thirty incinerator related staff and workers were randomly selected under the condition of three different working environments which are including fuel feeding area, operation office and administrative office.

2.2 Personal information: Questionnaires were used to collect information for exposure assessment which are general information (gender, age, weight, height) and operating information (jobs description, working hour, working frequency and working period.

2.3 Air sampling and analysis procedure

Air pollution exposure study was conducted by environmental sampling and hygiene survey during March – April 2015. Workplace air sampling, air samples were collected 8 hours-working continuously by personal pump at each working environments. Sampling, preserving and analyzing followed NIOSH standard method.

This study was approved by the Ethics Review Committee for Research, Department of Health, Ministry of Public Health.

2.4 Health Risk Assessment

In this study, inhalation risk assessment was conducted following the Risk Assessment Guidance for Superfund [6] as following equations:

$$EC = (CA \times ET \times EF \times ED) / AT$$

Cancer risk for benzene (leukemia) and ethylbenzene (liver hepatocellular adenoma or carcinoma) was calculated as following:

$$\text{Cancer risk} = IUR \times EC$$

Non-carcinogenic risk for benzene, toluene, ethylbenzene, xylene and styrene was calculated as following:

$$\text{Hazard Quotient} = EC / RfC$$

Where

EC	is exposure concentrations (mg/m^3)	
CA	is contaminants concentration in air (mg/m^3)	Air monitoring during 8 hours
ET	is exposure time (hours/day)	8 hours/day (8 hours day-shift)
EF	is exposure frequency (days/year)	312 days/year
ED	is exposure duration (years)	5 years
AT	is averaging time - When estimating cancer risk, AT calculated by lifetime (70 years) x 365 days/year x 24 hours/day - When calculating HQ for non-cancer effect, AT calculated by ED (5 years) x 356 days/year x 24 hours/day	
IUR	is inhalation unit risk - IUR for Benzene (Leukemia) is 7.8×10^{-6} per $\mu g/m^3$ [7]	
RfC	is inhalation reference concentration - RfC for Benzene (decreased lymphocyte count) is 3×10^{-2} mg/m^3 [7] - RfC for Ethylbenzene (developmenta toxicity) is 1 mg/m^3 [8] - RfC for Toluene (neurological effects) is 5 mg/m^3 [9] - RfC for Xylene (impaired motor coordination) is 1×10^{-1} mg/m^3 [10] - RfC for Styrene (CNS effect) is 1 mg/m^3 [11]	
Cancer risk	Cancer risk of more than 10^{-6} considers an unacceptable level for carcinogenic effect of concern.	
HQ	HQ and HI of more than 1 consider an unacceptable level for non-carcinogenic effects.	
HI	Hazard Index (multiple substances)	

3. Results and discussion

3.1 General characteristic

Waste management technology is a stoker incineration with reverse-acting grate. The overall availability is 600 tons/day and generates electricity up to 14 MW for using in plant 24 hours continuously and sale for Provincial Electricity Authority. The pollution control systems are Semi Dry Scrubber, Bag Filter and CEMs.

Sample population is 30. Incinerator's staff included 18 men (60%) and 12 women (40%). There are 6 feeding staff (20%), 9 operation staff (30%), and 15 office staff (50%). The average age is 32.17 (±8.26) years.

3.2 Concentration of air pollution at the waste incinerator site

The 8 hours average of all heavy metal and VOCs concentrations in differences sampling areas are presented in **Table 1**. The concentration of mercury was under the detection limit, while concentrations of cadmium, lead, manganese, and nickel were less than 0.001 mg/m^3, they were not included in the calculation of cancer risk and non-cancer risk (HQ). However, mean concentrations of

benzene, toluene, ethylbenzene, xylenes and styrene were 0.080, <0.001, 0.031, 0.043, and <0.001 mg/m3 respectively. The concentration of each chemical was derived from sampling area, concentrations of benzene, ethylbenzene and xylenes in operation room and office are higher than at the feeding area. Ventilation may be related to the result because the operation office and the administrative office are closed systems while the feeding area is an open system.

Table 1 Concentration of air pollution at the waste incinerator site.

Sampling Area	Concentration (mg/m^3)									
	Air Heavy Metal					Air VOCs				
	Hg	Cd	Pb	Mn	Ni	Benzene	Toluene	Ethylbenzene	Xylene	Styrene
Feeding Area	ND	<0.001	<0.001	<0.001	<0.001	0.056	<0.001	0.0005	0.0005	<0.001
Operation Room	ND	<0.001	<0.001	<0.001	<0.001	0.097	<0.001	0.0417	0.0412	<0.001
Office	ND	<0.001	<0.001	<0.001	<0.001	0.087	<0.001	0.0502	0.0882	<0.001
Mean	ND	<0.001	<0.001	<0.001	<0.001	0.080	<0.001	0.0308	0.0433	<0.001
Standard (OSHA : TWA)	**0.1**	**0.005**	**0.05**	**5**	**1**	**1 ppm**	**-**	**-**	**100 ppm**	**100 ppm**

3.3 Cancer risk and Non-cancer risk

VOCs concentrations were lower than time-weighted average (TWA) recommended by OSHA [12]. However lifetime cancer risk (leukemia) of being exposed to benzene by inhalation from working in feeding area, operation room and office were 8.88×10^{-6}, 1.53×10^{-5}, and 1.38×10^{-5} respectively. **(Table 2)** The cancer risk was exceeding the acceptable of 1 in 1,000,000. While risk estimates of non-cancer effects did not exceed the risk level (both HQ and HI were lower than 1).

Table 2 Cancer risk and non-cancer risk

	Cancer Risk	**Non-Carcinogenic risk (Hazard Quotient : HQ)**				
	Benzene	**Toluene**	**Ethylbenzene**	**Xylene**	**Styrene**	**Hazard Index : HI**
Critical effect	Leukemia	Neurological effects	Developmenta toxicity	decreased rotarod performance	CNS effect	
	IUR: 7.8×10^{-6} per ug/m^3	RfC : 5 mg/m^3	RfC : 1 mg/m^3	RfC : 0.1 mg/m^3	RfC : 1 mg/m^3	
Sampling Area						
Feeding Area	8.88×10^{-6}	2.92×10^{-5}	1.46×10^{-4}	0.0015	1.46×10^{-4}	0.002
Operation Room	1.53×10^{-5}	2.92×10^{-5}	1.22×10^{-2}	0.12	1.46×10^{-4}	0.132
Office	1.38×10^{-5}	2.92×10^{-5}	1.46×10^{-2}	0.25	1.46×10^{-4}	0.272
Mean	1.26×10^{-5}	2.92×10^{-5}	8.99×10^{-3}	0.12	1.46×10^{-4}	0.135

Conclusion and Recommendation

Concentration of air heavy metal is quite not the problem in this study area and an average 8 hours of VOCs concentrations including benzene, toluene, ethylbenzene, xylene and styrene in this study are lower than the occupational limit of that defined by international organization. However, benzene, ethylbenzene and xylene are consistently higher indoor (operation office and administrative office) than outdoor (fuel feeding area). In the same way lifetime cancer risk from benzene exposure via inhalation is higher indoor than outdoor. Some prevention measures should be taken to reduce

risks, such as increasing of ventilation and using of air cleaners in indoor environment. In addition risk communication should be introduced to the staff to protect themselves properly.

References

1. Department of Pollution Control. 2014. A roadmap for waste and hazardous waste management. National Council for Peace and Order approved version. 26 August 2014.
2. Gochfeld M. Incineration: health and environmental consequences. Mt Sinai J Med. 1995 Oct;62(5):365–374.
3. Miyake Y, Yura A, Misaki H, Ikeda Y, Usui T, Iki M; Shimizu T. Relationship between distance of schools from the nearest municipal waste incineration plant and child health in Japan. European Journal of Epidemiology 2005; 20: 1023–1029.
4. Shy, C.M., D. Degnan, D.L. Fox, S. Mukerjee, M.J. Hazucha, B.A. Boehlecke, D. Rothenbacher, P.M. Briggs, R.B. Devlin, D.D. Wallace, R.K. Stevens, and P.A. Bromberg. 1995. Do waste incinerators induce adverse respiratory effects? An air quality and epidemiological study of six communities. Environ. Health Perspect. 103(7-8):714-724.
5. Maitre, A., Collot-Fertey, D., Anzivino, L., Marques, M., Hours, M., & Stoklov, M. (2003). Municipal waste incinerators: air and biological monitoring of workers for exposure to particles, metals, and organic compounds. Occupational and Environmental Medicine, 60(8), 563–569. http://doi.org/10.1136/oem.60.8.563
6. U.S. Environmental Protection Agency [U.S, EPA]. Risk assessment guidance for superfund volume i: human health evaluation manual (Part F, Supplemental Guidance for Inhalation Risk Assessment). Washington, D.C: Office of Emergency and Re medial Response; 2009.
7. U.S. Environmental Protection Agency, Integrated Risk Information System [IRIS]. Integrated risk information for benzene [Monograph on the internet]. Washington, DC: U.S. Environmental Protection Agency; 2003 [cited 2016 December 6]. Available from: https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=276
8. U.S. Environmetal Protection Agency, Integrated Risk Information System [IRIS]. Integrated risk information for ehtylbenzene [Monograph on the internet]. Washington, DC: U.S. Environmental Protection Agency; 1991 [cited 2016 December 6]. Available from: https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=51
9. U.S. Environmental Protection Agency, Integrated Risk Information System [IRIS]. Integrated risk information for toluene [Monograph on the internet]. Washington, DC: U.S. Environmental Protection Agency; 2005 [cited 2016 December 6]. Available from: https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=118
10. U.S. Environmental Protection Agency, Integrated Risk Information System [IRIS]. Integrated risk information system for xylene [Monograph on the internet]. Washington, DC: U.S. Environmental Protection Agency; 2003 [cited 2016 December 6]. Available from: https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=270
11. U.S. Environmental Protection Agency, Integrated Risk Information System [IRIS]. Integrated risk information system for Styrene [Monograph on the internet]. Washington, DC: U.S. Environmental Protection Agency; 1992 [cited 2016 December 6]. Available from: https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=104
12. OSHA. (2012). *Chemical sampling information*. Retrieved April 21, 2014, from Occupational Safety & Health Administration [OSHA]: https://www.osha.gov/dts/chemicalsampling/toc/toc_chemsamp.html

Need for a wetland guide for Northern Quebec

Francois Quinty

Global warming speeds up the development of northern regions of Canada where multiple resources, for a large part mining and energy resources, become more readily available. In the Province of Québec, the Provincial government created the "Société du Plan Nord" that aims at promoting projects in the north of the province including mining projects and the construction of infrastructures such as transportion facilities. Despite a recent slowdown caused by low market prices, some mining projects are being developed. The first stage of these projects involve a permitting process such as Environmental Impact Assessments, which includes wetland identification, delineation and classification.

In Canada, the environmental permitting process is a provincial jurisdiction except for designated projects that are under federal jurisdiction. For example, projects that involve activities in more than one province fall under federal rules. In Quebec the provincial regulation (Environment Quality Act) requires compensation for wetland losses if they cannot be avoided or minimized. So far, protection of wetlands or buffer zones around wetlands, ecological enhancement, restoration and creation were the preferred compensation options. However the Quebec Environment Quality Act is being revised and compensation options may be modified. For instance, monetary compensation could become favored while protection of wetland and buffer zones around wetlands might no longer be accepted.

Quebec Wetland Delineation Guide

The compensation level determination is primarily based on the lost of wetland areas, which makes wetland delineation a crucial factor in establishing the compensation. In order to better implement this regulation, the Québec Department of Sustainable Development, Environment, and Fight against Climate Change (DSDEFCC) published a wetland classification and delineation guide (Bazoge *et al.*, 2015). That guide recognizes four wetland classes: shallow water (pond), marsh, swamp and peatland. It also integrates the concept of "mosaic" that includes terrestrial "islands" being more or less surrounded by wetlands.

Botanical, hydrologic and soil criteria are used along with other wetland features to delineate wetlands:

- Botanical criteria are based on the presence of wetland obligatory (OBL), facultative (FACH) and non-indicative (NI) plant species according to the plant list included in the guide. The dominance of OBL and FACH plant species lead to the classification of a site as wetland.
- Drainage, organic layer thickness and degree of decomposition, and hydromorphic features (gleysation and mottles) in mineral soils are the main soil criteria used to classify wetlands.
- Features associated to hydric conditions such as the presence of black litter, sediments and mosses on tree trunks are also taken into account in the classification process.

Boreal Forest Wetlands

The current wetland guide was developed for the meridional part of the Québec territory that is dominated by deciduous and mix forests. However, rules of the guide can hardly be applied in the boreal forest, where these rules may lead to incorrect wetland classification and delineation. The main reason leading to such a situation is that some wetland indicative plant species are commonly found in dry habitats in northern conditions. The best example is Labrador tea (*Rhododendron groenlandicum*) that is considered as an obligatory wetland species in the south but that is almost ubiquitous in the boreal forest. Black spruce (*Picea mariana*), a facultative species in the wetland guide is the dominant tree species in the north where it grows in hydric, mesic and xeric conditions. Actually, a large part of the boreal forest is split into two categories, the Black spruce moss forest (humid) and the Black spruce lichen forest (xeric) that are both obviously dominated by black spruce. On the other hand Balsam fir (*Abies balsamea*) a species that is restricted to wet stations in the north is not indicative of wetlands in southern Québec. An explanation for this situation is that some species are restricted to particular habitats when they are at the limit of their range, so that boreal species are found in wetlands in the temperate forest while some widespread southern species are confined to wet depressions in the north.

Problems that could be misleading also occur in regards to soil criteria. For example, an organic horizon of a minimum thickness of 30 cm must be present to categorize a site as a peatland. As we move north, climatic conditions reduce biologic productivity that, in turn, decreases organic matter accumulation rate in peatlands with the consequence that some peatlands cannot be classified as such because of peat thickness lower than 30 cm. This is especially true for fens (namely spring-fens) that can even develop on more or less sloping conditions due to runoff water supply for a large part of the summer. On the other hand, folisol deeper than 30 cm composed of moss debris can be found in mesic and hydric stands within the spruce moss forest that covers extended area in the boreal forest. Although folisol are not considered as hydromorphic soils, their identification as such maybe problematic. When associated with the presence of black spruce and Labrador tea, two wetland indicator species according to the current guide, such a combination may wrongly lead to classify terrestrial habitat as wetland.

Consequently, these factors (plant and soil indicators) can, in many cases, lead to over or under estimation of wetland surface and even lead to the classification of terrestrial habitats as wetlands or the opposite. A review of plant wetland status and defining an organic soil depth for northern Québec would help solve the problem without requiring important efforts at least for the boreal forest.

Arctic and Subarctic Wetlands

Problems more specific to the subarctic and arctic tundra zone are the lack of knowledge by practitioners and analysts as well as access to reliable data. Both can lead to misinterpretation as to the presence of wetland and negatively affect some projects. For example, the simple presence of *Carex* species has been wrongly interpreted as indicators of wetland. Few biologists have a functional knowledge of northern plant species and most of them have not been categorized in regards to their wetland status. Similar situations may happen with some periglacial wetland features. While the current wetland guide uses botanical, hydrologic (drainage) and soil criteria, in northern environment soil and hydrology are controlled by geomorphologic processes that are simply not taken into account in the wetland evaluation process for the meridional zone. In the subarctic zone, ground frost is the driving force of a great diversity of geomorphological processes directly responsible for the spatial distribution of wetlands. These processes depend largely on the nature of the surficial deposits and the level of water saturation in the ground. Geomorphological processes are also extremely dynamic and can

cause rapid fluctuations in water conditions during a year. For example, tundra mud boils may be sporadically water saturated at the beginning of thawing of the active layer over permafrost in summer, but quickly take on a hard, compact consistency after only a few weeks (thixotropy). In contrast, areas on some slopes may be continuously water saturated throughout the summer season, due to the presence of solifluxion lobes. A similar situation exists down slope from snowbeds and snow patches that supply water as they melt over the summer. These factors lead to the formation of wetlands that can easily be classified as marsh or low shrub swamp based on the dominant vegetation (herbaceous or shrubs species) but there is a lack of knowledge about plant communities composition and processes that characterize them and that would allow a more precise identification and classification. Hence there are no criteria to help delineate these wetlands.

Impact Assessment

The global warming poses new challenges for the preparation of environmental impact assessments in northern latitudes like northern Québec especially in regards to wetlands. Wetlands can cover extensive areas in cold regions because the presence of permafrost impedes drainage and creates waterlogged soil conditions. On the other hand the global warming is more pronounced at these latitudes resulting in higher temperatures and a longer frost free season that directly affect permafrost by inducing thawing and increasing the depth of the active layer. Permafrost degradation increases available water in immature and non-organized drainage network. When thermokarst ponds cover an important proportion of an area, the drainage network does not have the capacity to efficiently evacuate the water. Excess of water, generated by snowmelt and permafrost thawing, stagnates on the terrain and could transfer additional heat into the ground. Hence a non-organized drainage networks allows water accumulation that contributes to the fast soil warming in the watershed. That leads to an increase of groundwater movement and storage capacity in the soils and the drainage networks must adapt to these new hydraulic conditions. As long as a frozen layer is present at shallow depth, this effect can favor the presence of wetlands because more water becomes available, but in the longer term, the drainage network development can induce disappearance of permafrost that will facilitate drainage and lead to dryer conditions and important change to wetland.

Global warming also affects plants by lengthening growing season and increasing available energy (degree-day). Better plant growth will favor snow accumulation that in turn will protect plants against frost.

These effects of global warming already create highly dynamic conditions in the arctic and subarctic zones that complicate the description of a rapidly evolving environment. In addition, the assessment of impacts and elaboration of mitigation measures require the integration of factors and processes that are occurring or are likely to occur in a near future whose effects are not well understood. In some cases the lack of knowledge is an obvious problem. Major difficulties arise when trying to assess the impact of a project on wetlands. It may be difficult to discriminate between the effect of a warmer climate and (that of infrastructure such as civil linear infrastructures or mining facilities) human activities.

This situation can be illustrated by a project aiming at selecting the best road location among a few options for a mining project in Northern Québec. The road construction was subject to an environmental authorization certificate that required a description of wetlands and the assessment of impact of the road on the environment and the impact of environment on the road. The Québec wetland classification and evaluation system proved to be inapplicable (unadapted) in this arctic context. For instance, it was not clear if some periglacial features such as tundra mud boils should be considered as wetlands. Evaluation of impact and mitigation measures took

into account the effect of snow ploughing that could affect permafrost and create ground disturbance locally. The presence of nearby snow patches was taken into account as they may present a threat to the road if they increase in size due to more abundant precipitation and/or induce permafrost thawing and increased runoff. In the end, despite a deep analysis of the situation, lot of uncertainties remained.

In such conditions, it becomes obvious that a wetland identification and delineation guide should be developed properly for the subarctic and arctic zones of Québec to take into account the specificity of soil, hydrology and vegetation of cold regions. Such a guide should include a reliable list of indicator plant species. In fact, the current wetland identification and delineation guide provides wetland affinity for about 1280 taxa out of the 2854 species found in Québec, i.e. less than half of the total number of plant species. Hydrological and soil criteria should also be adapted to subarctic and arctic conditions and consider the influence of the global warming on the dynamic of wetland and permafrost. The increase of knowledge about northern plant species, geomorphology and arctic environmental conditions are leading to the preparation of such a guide. This work should be conducted by a team of specialists including biologists and geomorphologists with a good deal of experience in cold regions.

References

Bazoge, A., D. Lachance et C. Villeneuve. (2015). Identification et délimitation des milieux humides du Québec méridional. Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, Direction de l'expertise en biodiversité et Direction de l'aménagement et des eaux souterraines, 64 pages + annexes.

Follow-up monitoring and adaptive management in EIA process: a case study in the new port of Veracruz construction phase

Ramírez-Macías, José Isaac[1]; Liaño-Carrera, Francisco[2]; Baños-Illana, Jorge E.[2]; Gómez-Barrero, Arturo E[1]. & Guzmán-Ricardo, Carlos R.[1]

[1]Argo Consultores Ambientales S.A. de C.V. Coordinación de Protección Ambiental (contact author e-mail: isaac.ramirez@argoconsultores.com)

[2] Administración Portuaria Integral de Veracruz S.A. de C.V. New Port of Veracruz Management.

1. Abstract.

Follow-Up is a fundamental stage in the Environmental Impact Assessment process. Follow-up monitoring aims to evaluate projects performance in terms of the environmental impact level predicted and later authorized. Ideally, surveillance and compliance monitoring results should be continuously evaluated to determine the need for adjustment in the environmental management actions (mitigation measures included). Follow-up monitoring and adaptive management become extremely important in large-scale projects. The port of Veracruz began an ambitious expansion project in 2015 and implemented an Environmental Management System (EMS) based on ISO 1400 standards, which include an Environmental Monitoring Program (EMP). Because of EMS operation and EMP results, important management actions have been executed to keep environmental performance of the project in an acceptable level. The new port of Veracruz is a successful case of adaptive management based on environmental monitoring.

2. Port of Veracruz expansion project.

Port of Veracruz Authority (APIVER) obtained in 2013 an environmental impact authorization to build and operate its expansion project, known as the New Port of Veracruz. This project represents one of the biggest infrastructure projects in Mexico in recent times and the most important port construction in last one hundred years.

The project consists of two construction stages; the first (2014-2018), which started in 2014, involves the construction of a 4.2-kilometer western breakwater; there will be 2.8 kilometers of construction along the wharf where the first container terminal (720 meters) will be located, accommodating four berths and slated to begin operations in 2018. In total, the first stage will bring berth capacity to eight positions. A satellite terminal with five positions will also be built to handle other cargo. It will have a depth of fifteen meters. The second stage (2019-2030) includes the construction of the eastern breakwater of 3.5 kilometers and the rest of terminals. The project will finally have a 35-berth capacity and 900 hectares area (440 hectares water expansion) and will increase current port capacity in a 400%.

The port of Veracruz is located next to a marine protected area (MPA) denominated Veracruz Reef System (VRS). This MPA imposed to the port expansion project complex restrictions environmentally speaking due to the importance of the ecosystems which it protects. Main environmental issues of the new port of Veracruz incorporated in the environmental impact statement are related to some extent with the protection and/or conservation of coral reefs in the MPA. See Figure 1.

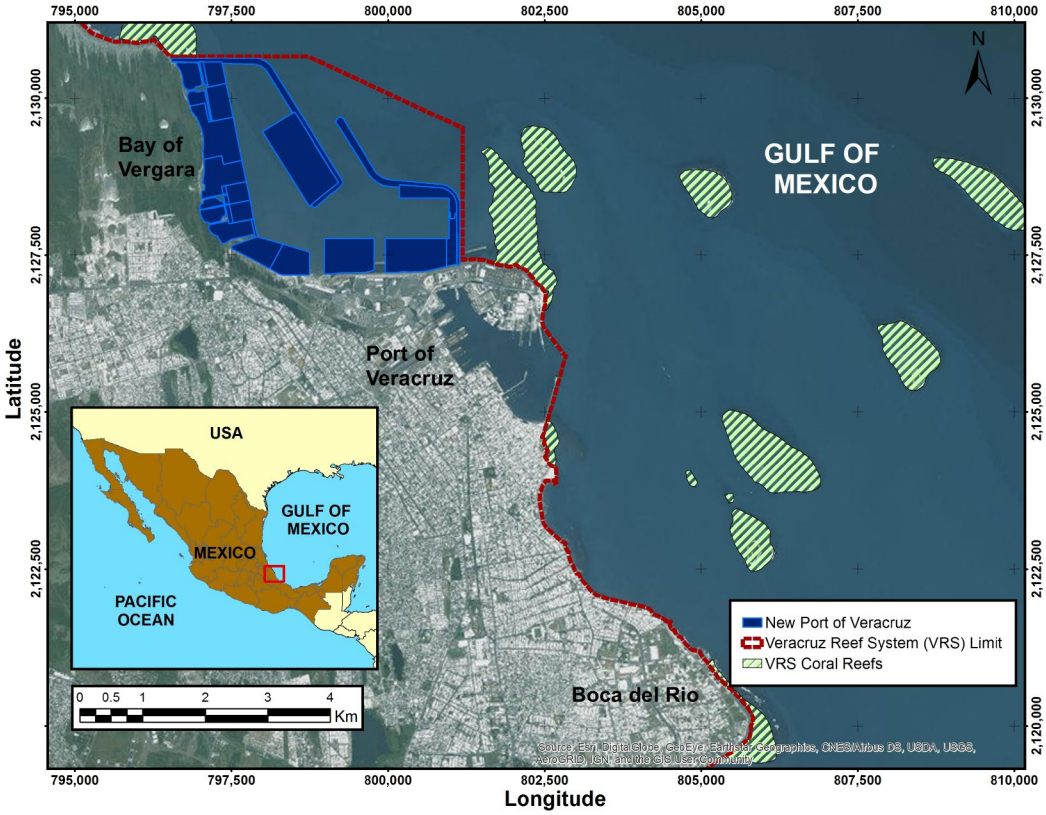


Figure 1 Port of Veracruz Expansion Project Location

3. Environmental Monitoring Program.

Monitoring refers to the measuring of physical, chemical, social, economic and ecological aspects related to environmental impacts (Glasson, Therivel, & Chadwick, 2005). Environmental Impact Assessment (EIA) follow-up and audit usually refers to a set of actions developed after project environmental impact authorizations including: monitoring, auditing, ex-post evaluation, post-decision analysis and post-decision management (Arts, Caldwell, & Morrison-Saunders, 2001). Morrison-Saunders et al. (2007): defined EIA follow-up simply as the monitoring and evaluation of a project plan (that has been subject to EIA) for management of, and communication about, the environmental performance of that project or plan.

The environmental impact assessment (EIA) procedure in Mexico was recently established in the 1980s when legal framework appeared. As it happens at international level, most attention was centered on the prevention nature of environmental impact assessment to anticipate major negative impacts prior environmental permits approval. But little attention has received the follow-up phase, which can answer if actual impacts are in accordance with conditions and predictions made in environmental impact statement (EIS) (Marshall, 2005) . Were all measures proposed in EIS adequate and/or enough to prevent, compensate and mitigate real environmental impacts? Monitoring, ideally, should answer that kind of questions.

Although EIA follow-up is clearly necessary in practice. However, in Mexico it seems to be more of a theoretical approach, which has been undertaken just partially in few cases. Here we present the new port of Veracruz follow-up monitoring and highlight how it has been the base of project environmental performance evaluation.

The Ministry of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT) is the government agency in charge of regulating EIA process in Mexico and has elaborated environmental impact assessment guidelines which incorporate monitoring and follow-up. Project proponents in Mexico use those guidelines for the preparation of EIS and must include an environmental monitoring program.

Due to its inherent complexity and magnitude, the port of Veracruz expansion project was subject to environmentalist opposition for over a decade before it's authorization by the SEMARNAT and the baseline information integrated into the EIS included more than ten years monitoring covering aspects of port design technical studies, socioeconomic and ecological material. And consequently, the environmental monitoring program initially proposed, encompassed a full range of variables to be followed during the fifty years of project life.

Once SEMARNAT evaluated the EIS, it also added a series of additional mitigation measures to the original proposal that strengthened the environmental monitoring program, its scope and objectives, becoming a central instrument for the evaluation of the environmental performance of the port expansion project.

To face the challenge of fully complying with the requirements of the environmental impact permit, the port of Veracruz authority designed and implemented, in 2014, an Environmental Management System (EMS) based on ISO 1400 standards, focused on the port of Veracruz expansion project which includes an Environmental Monitoring Program (EMP). New port construction phase began in 2015 and here we present relevant results of EMP and describe related management actions based on environmental performance evaluation of the project.

The environmental management system covers three main objectives that, in sum, help to evaluate and communicate the environmental performance of the port expansion project. The objectives pursued by the EMP are:

a. Total permit conditions and measures compliance through the systematic control of the actions taken by the port authority, construction companies and other actors involved in the project.
b. Monitoring and continuous evaluation of the project´s environmental performance.
c. Communication and reporting of environmental performance to government agencies, evaluation committee, and other interested parties.

A special office, Environmental Protection Coordination (EPC), was created by the Port of Veracruz Authority to operate the EMS. Follow-up monitoring is executed by several specialized companies and universities and all information as part of EMS procedures.

An important aspect to highlight of the environmental impact permit of the Veracruz port extension project is the existence of an autonomous entity that oversees the correct project compliance. This entity is represented by the Veracruz University, which also submits an annual report to a Technical Committee represented by different government agencies and academic institutions.

4. New port of Veracruz follow-up monitoring relevant results and related management actions.

As it was mentioned before, the new port of Veracruz got its impact assessment permit in 2013 and began the constructions phase in 2015. In this period, the activities with the greatest impact potential were: rock dumping to conform the western breakwater and dredging of the navigation channel. Considering these activities, monitoring actions were centered on sediment dynamics in Vergara's Bay and the coral reefs closer to the new port construction site.

Prior to the start of the construction phase, the monitoring related to sediments was centered on sedimentation rates and coral reefs health assessment. And, a silk curtain system was built and deployed as one of the main mitigation measures regarding sediments control during the port construction phase.

Once the northern breakwater construction began, the silk curtains system did not perform as it was planned. The silk curtains system was supervised daily and finally was adapted and operated under special protocols that took into account deployment and retreat, monitoring and a maintenance program. The adapted protocols to manage the silk curtains system was approved by main stakeholders and then approved by SEMARNAT. However, it was necessary to assess the real effects of sediment input caused by rock dumping.

In 2015 the Port of Veracruz Authority began a sediment transport monitoring in order to set the baseline for a further preventive monitoring system during dredging execution. But this monitoring also contributed to assess rock dumping impact on sediment transport in Vergara´s Bay. Sediment transport have been monitored for 24 months so far, using vessel mounted and fixed Acoustic Doppler Current Profilers (ADCP) and it was determined that rock dumping, independently of silk curtains, had a punctual (300 – 400 square meters) and temporal effect (three to four hours before settling) demonstrating with a "*measured impact*" the real effect of rock dumping (Figure 2, letter A).

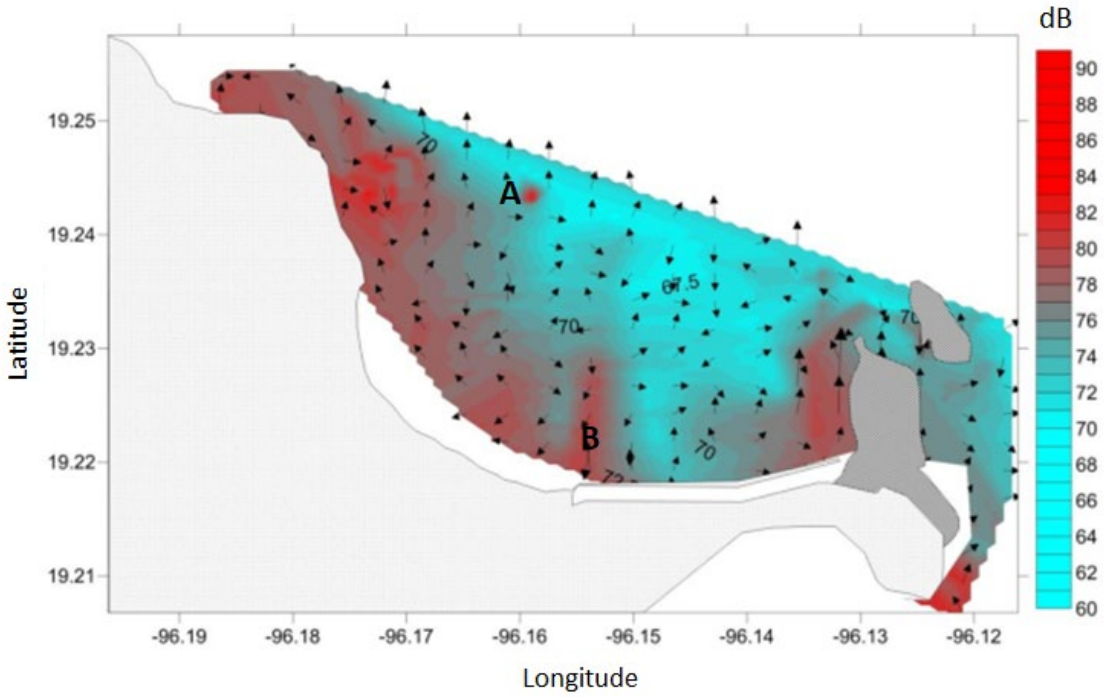


Figure 2 Sediment transport map from 07 january 2016. Red color indicates values equal or higher than 80 dB which represents the 80th percentile of sediments concentration in the water column after24 months monitoring.

The same monitoring provided enough information to characterize natural and anthropogenic variation in sediment dynamics unrelated to port construction. For example, a sediment plume caused by a water treatment effluent discharged in Vergara's Bay persist 24 hours before particles settle (Figure 2, letter B).

Based on information from sediments transport monitoring, a sophisticated preventive and management system for dredging was built. The system relies on real-time maps generated every 30 minutes by four fixed ADCPs. Real-time maps will be available to decision makers and public. An alert system was also created to send text messages and e-mails to decision makers so that they can take preventive actions such as dredging production declines or pauses. The latest version of the monitoring system was elaborated with the participation of the

external supervisors of the University of Veracruz, the authorities of the protected natural area (VRS) and researchers with expertise in sediment dynamics.

5. Conclusions.

- Major infrastructure projects need to incorporate follow-up monitoring to correctly assess environmental impacts.
- An adaptive management scheme is also fundamental to change in accordance with project environmental performance.
- To promote different stakeholders participation in environmental assessment of a project is an important component in follow-up and post-audit
- We consider the Veracruz port expansion project as a good example of how environmental management can rely on monitoring to ensure the best practice in post permit environmental impact assessment procedures.

6. References.

Arts, J., Caldwell, P., & Morrison-Saunders, A. (2001). Environmental impact assessment follow-up: good practice and future directions — findings from a workshop at the IAIA 2000 conference. Impact Assessment and Project Appraisal, 19(3), 175–185. https://doi.org/10.3152/147154601781767014

Glasson, J., Therivel, R., & Chadwick, A. (2005). Introduction to Environmental Impact Assessment. Assessment (Vol. 2nd). https://doi.org/10.1016/0169-2046(95)90007-1

Marshall, R. (2005). Impact Assessment and Project Appraisal Environmental impact assessment follow-up and its benefits for industry. Impact Assessment and Project Appraisal, 23(3), 191–196. https://doi.org/10.3152/147154605781765571

Morrison-Saunders, A., Marshall, R., Arts, J. (2007). EIA follow-up: international best practice principles. Special Publication Series No. 6. Fargo, USA: International Association for Impact Assessment.

Morrison-saunders, A., Arts, J., & Baker, J. (2001). EIA follow-up. Impact Assessment and Project Appraisal, 19(4), 289–296.

Sustainability in infrastructure projects proposed for São Paulo state / Brazil and their vulnerability to climate change

Presenting Author: Jose Luis Ridente Junior | Coauthor (s): Fabiola Sacchielle Pagliarani, Ivan Carlos Maglio and Carlos Henrique Aranha,

Abstract

Considering the scenario of climate change, in accordance with the latest reports of the Intergovernmental Panel on Climate Change (IPCC), it's possible to verify that the frequency of extreme climatic events tends to be higher, with potential consequences not completely known as of yet.

In this context, this article focuses on analyzing some environmental studies on infrastructure projects in São Paulo state, considering the different geomorphological compartments and their potential environmental fragilities in face of climatic changes.

Key words: climate change, infrastructure, environmental impacts assessment

Introduction

The studies on climate change present a change in the dynamics of the climate over the past few decades, whose models indicate a continuity in the times that follow, and this has been assumed in this article.

As per the first National Assessment Report (Relatório de Avaliação Nacional) - RAN1 of the Brazilian Panel of Climate Change (Painel Brasileiro de Mudanças Climáticas) - PBMC, the climate in Brazil will be warmer, with a gradual increase varying from 1° to 6° C by the year 2.100 in relation to the average temperature recorded at the end of the 20th century. In the South and Southeast regions of the country, an increase in rainfall is also expected.

The environment of São Paulo state

The predominant climate in São Paulo state is Tropical Atlantic, in areas with proximity to the coast, and Tropical Altitude, which prevails in the interior, in places of high altitudes. The average annual temperature ranges from 20° to 22° C. The annual precipitation average is around 1.400 mm, mainly concentrated in the summer. However, in the Serra do Mar Mountains the average is over 2.500 mm per year.

The state is located in the southeastern region of Brazil and presents diverse landscapes. According to ALMEIDA (1964), the state presents four major geomorphological domains, from east to west: the Coastal Plains, Atlantic Plateau, Peripheral Depression and Western Plateau, according to Figure 1 and Table 1.

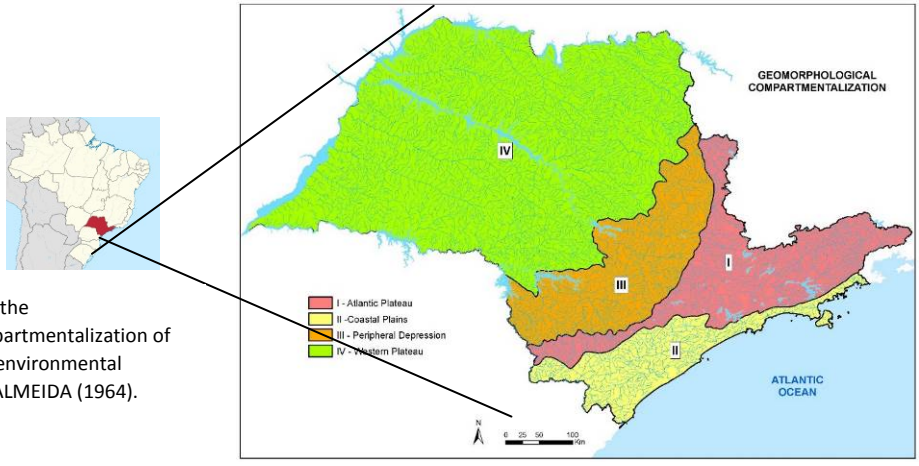


FIGURE 1 - Synthesis of the geomorphological compartmentalization of São Paulo state and its environmental fragilities according to ALMEIDA (1964).

TABLE 1 - Synthesis of the geomorphological compartmentalization of São Paulo state and its environmental fragilities according to Ross & Moroz (1997).

GEOMORPHOLOGICAL DOMAINS	GEOLOGICAL FORMATION	FRAGILITIES	SOCIOECONOMICS
Coastal Plains	Sandy Tertiary and Quaternary sedimentary rocks with levels of organic clay	Very high - subject to floods, shallow water table and inconsolidated sediment subject to constant accommodation, and high susceptibility to the undertows.	2 million people. Petrochemical industries, International trade Ports, coast resorts aimed at tourism.
Atlantic Plateau	Igneous and metamorphic rocks with relief of hills and mountains. Altitudes between 20 and 1000m. High slopes (> 40%). Tertiary sedimentary basins with sandy stones with low slopes.	Medium to high - strong erosive activities and high susceptibility to landslides. The sedimentary basins have medium to high fragility due to the potential of floods.	The most populous region of the state, with approximately 20 million inhabitants in the Metropolitan Region of São Paulo. Industries and services.
Peripheral Depression	Sedimentary rocks in the Paraná Basin of several lithology. Altitudes between 600 and 750m.	Low to medium - low erosive potential.	Region with important industrial poles and intense agricultural activity
Western Plateau	Sedimentary rocks of the Paraná Basin composed of sandstones and basaltic igneous rocks. Altitude between 500 and 600m.	Medium - greater stability in the processes of the physical environment. However, it has high susceptibility to linear erosive processes.	Predominantly agricultural and livestock activities with a focus on sugarcane used for ethanol production, in addition to orange, coffee and commodities.

Photos: Main geological, hydrological and climatic processes occurring in São Paulo state, which will undergo a change in its dynamics in the face of climatic changes.

Undertow

Landslides

Floods

Erosion

Strong Winds

In a rather general way, this table presents a picture of São Paulo state, and a scenario study of the projects that have been considered in this article.

The occupation history of this territory was marked by the transposition of the Serra do Mar Mountains, located between the Coastal Plain (Port of Santos) and the Atlantic Plateau (where the São Paulo metropolitan area is located). The escarpment of Serra do Mar has a slope of 800 meters and is an important route of connection between the industrial poles that have been developed in these regions. Its transposition has been carried out mainly by means of highways, railroads and pipelines, establishing the greatest economic flow of the country.

Infrastructure in São Paulo state

In Brazil, São Paulo state has the largest Gross Domestic Product – GDP - in the whole country, due to its industrial production, agriculture and services. It has a transportation infrastructure that stands out in relation to the rest of Brazil.

The state's 44 million inhabitants are scattered across a territory of 248.209 km ² with three cities containing populations of more than one million inhabitants. Namely, there are São Paulo, which is South America's largest metropolis with almost 11 million inhabitants. Additionally, there are also six cities with more than 500.000 inhabitants.

In this context, planners have considered the region of the macro metropolis of São Paulo state, which represents the largest and most complex urban system in the country. This area has been consolidated over the last ten years. At the end of this century's first decade, there were 173 municipalities in total which accounted for 73.3% of the total population as well as 82.7% of the state's GDP and 27.7% of the Brazilian GDP. The most urbanized area of the country, this immense region is a result of the unfolding of demographic, economic and urban dynamics.

Methodology

Despite the infrastructure mainly being installed during the 1960s and 1970s, and from its expansion and improvements implemented in the last two decades, it is still considered insufficient and obsolete for the continuity of the growth of the economy of the state and the country, and for the well- being of the population. To meet expected demand, it is necessary to expand and modernize the entire network for different modes of transportation.

In this way, this research was prepared to analyze which of the enterprises implemented in the last two decades in the state have in their preliminary environmental studies some approach or consideration regarding the new conditions predicted by global climate change.

The considered criteria to the research was:

- Selection of infrastructure projects in the last 20 years that were the subject of environmental studies to obtain environmental licenses;
- Identification of major transportation projects;
- Projects located in the different geomorphological compartments of the São Paulo State; and
- Selection of projects, among those selected, that the authors of of the paper had some technical participation in any stage of environmental impact assesment, or during the construction phase of the projects. Analysis of the expected environmental impacts and mitigation measures proposed in the studies.

Various Reports of Environmental Impact Studies were analyzed for modernization and deployment of highways (Rodoanel, Tamoios), improvements in public transportation system for urban trains, new subway lines (Linha 5 Lilás), new pipeline networks (GASPAJ) and implementation of underwater tunnels (Submerso Santos-Guarujá). The projects that are the objects of these studies are located in different environments of the state, being susceptible to different types of fragilities and vulnerabilities.

Although the analysis shows that enterprises with more modern projects and construction techniques are foreseen, and that new themes are being incorporated, the explicit approach on risks to climate change have not been realized. It is evident in the environmental studies that the analysis of the environment in an integrated way predicts the occurrence of surface processes in function of the behavior of the land and occupation. However, in none of them has their behavior in a future scenario under more severe climatic conditions been predicted, and as a result of the necessary design changes if there are significant changes in the dynamics of their particular weaknesses.

Based on the analysis of vulnerabilities defined by natural conditions and how the land was occupied, the IPCC wrote the 5^{o} report of Working Group II, focusing on the concepts of risk analysis.

The PBMC showed in the RAN1 that in the Southeast of the country, the projections indicate a relatively low temperature increase between 0,5^{o} C and 1^{o} C until 2040, with a 5% to 10% increase in rain. Between 2041 and 2070, trends of gradual increase of 1,5^{o} C to 2^{o} C in temperature and 15% to 20% in rainfall should be maintained. However, such trends should become even more pronounced at the end of the century, when the climate is expected to be between 2,5^{o} C and 3^{o} C warmer and between 25% to 30% rainier.

In this way, it can be considered that due to existing fragilities and with the increase of the occurrence of extreme events in a densely occupied region, more areas will be vulnerable and with a greater risk of accidents.

Considerations

Due to the fragilities of the environments in the state conditioned by the natural characteristics and the occupation of the land, the new enterprises are subject to the phenomena that may result in behavior alterations of frequency, intensity, comprehensiveness and significance.

In this way, it is possible to consider that:

- The Coastal Plain may intensify the processes of localized floods, salinization of groundwater, instability in building foundations, etc., due to sea level rises, elevation of the water table, liquefaction of the land and occurrences of undertows;
- The Atlantic Plateau may have an intensification of slope and flooding processes due to the increase in rainfall, which is already very high. In this way, the installed infrastructure would be subject to change in the vulnerability of wherever the it is located;
- In the Peripheral Depression and in the Western Plateau, the intensification of the processes of linear and superficial erosion can be predicted as well as of slides on the steepest slopes, in addition to floods located in the fluvial plains. As well as this, the increase in temperature may change the dynamics of agricultural production in the region.

Considering this framework, strategies and actions that will advance the generally resilient routes and infrastructures for sustainable development must be planned. Improving living conditions, the economy and environmental management, which must be implemented in the context of new environmental studies, is also recommended.

According PBMC (2014), the socio-environmental consequences of extreme events in Brazil in recent years reinforces the need for a national adaptation strategy in various sectors of economic activities.

Although international reports and scientific studies point to uncertainties in climate modeling, especially due to the difficulty of predicting socioeconomic aspects (GHG emissions, demography, technological development, among others), environmental studies for new developments in São Paulo state need to:

- Incorporate forecasts considering the predictions of increase occurrence of extreme events;
- Incorporate new design criteria for drainage systems, for security of structures, among others;
- Incorporate new systems of operational monitoring of infrastructure to increase the efficiency of forecasting actions and alert to the occurrence of these extreme events;
- To develop specific mitigation plans and contingency plans that incorporate new emergency operational procedures and protocols for harm reduction in natural disaster cases at the respective sites identified to withstand exceptional climatic events;
- Research and incorporate (even international) experiences of actions that increase resilience or responsiveness to extreme events;
- Apply globally a consolidated knowledge to international organizations such as the IPCC, UNISDR, to increase the engineering solutions of the infrastructure projects to be developed - incorporating future forecasts, testing and applying modeling in order to increase its accuracy.

Bibliographic references

ALMEIDA, F.F. M. 1964. FUNDAMENTOS GEOLÓGICOS DO RELEVO PAULISTA. Bol. Inst. Geográfico e Geológico, n.41, São Paulo. 1964

BRASIL. Pretendida Contribuição Nacionalmente Determinada do Brasil . Convenção-Quadro das Nações Unidas sobre Mudança do Clima. Disponível em: http://www.itamaraty.gov.br/images/ed_desenvsust/BRASIL-iNDC-portugues.pdf Acesso em: 07 feb. 2017

BRASIL. Ministério da Ciência, Tecnologia e Inovação. Secretaria de Políticas e Programas de Pesquisa e Desenvolvimento. Coordenação-Geral de Mudanças Globais de Clima. MODELAGEM CLIMÁTICA E VULNERABILIDADES SETORIAIS À MUDANÇA DO CLIMA NO BRASIL / Ministério da Ciência, Tecnologia e Inovação. Brasília: Ministério da Ciência, Tecnologia e Inovação, 2016. 590p. Il

CETESB. Companhia Ambiental do Estado de S DUTOS NO ESTADO DE SÃO PAULO. Disponível em: <http://emergenciasquimicas.cetesb.sp.gov.br/tipos-de-acidentes/dutos/dutos-no-estado-de-sao-paulo/> Acesso em: 31 jan. 2017

ESTADO DE SÃO PAULO. Sistema Hidroviário Paulista. Disponível em: http://www.dh.sp.gov.br/sistema-hidroviario-paulista/ Acesso em: 07 feb. 2017

EIA Gasoduto Paulínia-Jacutinga - ESTUDO DE IMPACTO AMBIENTAL GASODUTO PAULÍNIA-JACUTINGA – GASPAJ – PETROBRÁS 2006

EIA Rodoanel Norte - ESTUDO DE IMPACTO AMBIENTAL RODOANEL NORTE. Desenvolvimento Rodoviário S.A. – DERSA. 2010.

EIA Rodoanel Sul - ESTUDO DE IMPACTO AMBIENTAL RODOANEL SUL. Desenvolvimento Rodoviário S.A. – DERSA. 2004.

EIA Linha 5 – Lilás - ESTUDO DE IMPACTO AMBIENTAL LINHA 5-LILÁS DO METRÔ DE SÃO PAULO. Companhia do Metropolitano de São Paulo – METRÔ 2011

IBGE. Instituto Brasileiro de Geografia e Estatística. 2014. ESTIMATIVAS DA POPULAÇÃO RESIDENTE NOS MUNICÍPIOS BRASILEIROS COM DATA DE REFERÊNCIA EM 1º DE JULHO DE 2014. Disponível em: http://biblioteca.ibge.gov.br/visualizacao/livros/liv97744.pdf Acesso em: 08 fev. 2017

IPCC. Intergovernmental Panel on Climate Change. 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

PBMC. Painel Brasileiro de Mudanças Climáticas, 2014a. BASE CIENTÍFICA DAS MUDANÇAS CLIMÁTICAS. Contribuição do Grupo de Trabalho 1 do Painel Brasileiro de Mudanças Climáticas ao Primeiro Relatório da Avaliação Nacional sobre Mudanças Climáticas [Ambrizzi, T., Araujo, M. (eds.)]. COPPE. Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brasil, 464 pp.

PBMC. Painel Brasileiro de Mudanças Climáticas. 2014b. IMPACTOS, VULNERABILIDADES E ADAPTAÇÃO ÀS MUDANÇAS CLIMÁTICAS. Contribuição do Grupo de Trabalho 2 do Painel Brasileiro de Mudanças Climáticas ao Primeiro Relatório da Avaliação Nacional sobre Mudanças Climáticas [Assad, E.D., Magalhães, A. R. (eds.)]. COPPE. Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brasil, 414 pp.

ROSS, J. L. S. & MOROZ, I. C.. MAPA GEOMORFOLÓGICO DO ESTADO DE SÃO PAULO. Revista do Departamento de Geografia, São Paulo, v. 10, p. 41-58, nov. 2011. ISSN 2236-2878. Disponível em: <http://www.revistas.usp.br/rdg/article/view/53703/57666>. Acesso em: 10 feb. 2017.

Livelihoods and Ecosystem Services in Social Impact Assessments

By Hannah Mills, Marielle Rowan, and Marianne Lupton**

Introduction

The concept of ecosystem services was introduced into the IFC Performance Standards (PS) in 2012 and has recently been included within the World Bank's updated Environmental and Social Framework (2016). Ecosystem services are the benefits that people derive from ecosystems including products such as food, timber, fibre, and freshwater, termed 'provisioning services'[1]. Livelihoods are defined within IFC PS5 on land acquisition and involuntary resettlement as "the full range of means that individuals, families, and communities utilise to make a living, such as a wage-based income, agriculture, fishing, foraging and other natural resource-based livelihoods, petty trade and bartering". IFC PS5 identifies provisioning services as the same as natural resource assets, which contribute to livelihoods. There is varying analysis of the cross-cutting nature of livelihoods and ecosystem services within environmental and social impact assessments (ESIAs) and guidance literature. The analysis and discussions tend to focus on the biodiversity aspects rather than socio-economic implications. To contribute to addressing this gap, this paper presents ways to incorporate livelihoods and ecosystem services into the key stages of the social impact assessment (SIA) process based on the World Resource Institute's methodology.

The World Resources Institute (2013) methodology for incorporating ecosystem services into ESIA proposes the following key steps: (i) identify possible project impacts and prioritise ecosystem services for further study (scoping); (ii) establish the baseline of natural resource use; (iii) assess the significance of impacts; and (iv) identify mitigation and enhancement measures. Due to data limitations in the international context, budget and time constraints, the focus of ecosystem services work relating to livelihoods tends to focus on provisioning services that support livelihoods. Wherever provisioning services support natural resource-based livelihoods (including sustenance, fuel, building materials, medicines or ornamental purposes) then socio-economic impacts may occur.

During scoping, ecosystem services likely to be present within the area of influence are identified. The global oil and gas industry association for environmental and social issues (IPIECA) checklists (2011), describing various habitats, are a useful starting point. Questions answered for each service are: 1) Could the project change the quality or quantity of this service? 2) Who is impacted?

The next step identifies, through professional judgement of social scientists and ecologists, ecosystem services that could impact livelihoods. These services are then confirmed or amended through engagement with affected parties to ensure that priorities are correct and important services are not missed. The following questions are considered: 3) Could the project affect others' ability to benefit from the ecosystem service by tipping use over a threshold, triggering a regulatory response, or changing perceptions around availability or quantity? 4) Is the service important to people's livelihoods? 5) Are viable alternatives available? If answers to questions 3 and 4 are yes and the answer to question 5 is no, then the ecosystem service is assigned as a priority.

[1] The World Resources Institute identifies the full range of ecosystem services: provisioning services – defined in text; regulating services – the ecosystem's control of natural processes, such as climate regulation and erosion prevention; cultural services – nonmaterial contributions of ecosystems to human well-being, such as spiritual values and aesthetic enjoyment; and supporting services – natural processes that maintain the other services, such as nutrient cycling.

The paper describes methods for characterising baseline to better understand existing nature-based livelihoods; explains how significance can be attributed to impacts; and suggests mitigation and enhancement measures to better address livelihoods impacts. In particular, the importance of identifying ways to support livelihood restoration is considered. Case studies from Mott MacDonald's (a global consultancy) assignments accompany the analysis. The paper concludes that improved understanding of impacts to ecosystem services increases the likelihood of effective livelihood strategies being included in resettlement plans and other project management plans, therefore helping to safeguard the economic wellbeing of project-affected communities.

SIA Baseline

The objective of providing baseline is to help identify and monitor impacts by comparing pre- and post-project conditions of ecosystem service resource availability and access as well as livelihoods. Primary data is collected through field surveys, focus groups, measurements, observations, and consultations. Secondary data about natural resource use, shocks and trends provide a useful supplement to the season-specific timing of primary data collection. Typical secondary data sources for livelihoods and ecosystems are government socio-economic policies, censuses, ecological studies, civil society, and business reports. See a case study below that combines primary and secondary data for reporting natural resource-based livelihoods.

Baseline sections on economic context detail economic growth, per capita income, employment and unemployment rates, and livelihoods. Natural resource use descriptions should consider activities relying on land, ecology, water, and geology. Details of tenure (ownership systems) including rights to use, control, and transfer of land provide insight into groups who may be vulnerable from a lack of control of resources. Legacy and existing issues of conflict or struggles for land, water or other natural resources should be recognised if the project will exacerbate or change them.

Case Study for a multipurpose dam ESIA in West Africa: For a recent ESIA assignment, Mott MacDonald's SIA team considered the full range of natural resource-based livelihoods likely to be impacted: shea nut collecting, basket weaving, pito brewing, charcoal burning, honey making, farming, fishing, livestock managing, bushmeat collecting, and small scale mining. For each livelihood, focus groups were organised using the same participatory format based on the British Department for International Development (DFID's) sustainable livelihoods theory. The groups used brainstorming, ranking and categorisation activities to gather data on: (i) vulnerability context, shocks, stresses and critical trends; (ii) livelihood assets and outcomes; (iii) seasonal and gender aspects; (iv) access to assets.

To report the livelihoods baseline, a summary table was prepared using primary data from the focus groups and secondary data. Livelihood aspects encapsulated in the table were a) contexts, conditions and trends; b) livelihood resources; c) institutional processes and organisational structures; d) livelihood strategies; and e) sustainable livelihood outcomes. The focus group information was presented showing assets and resources required, enabling and restricting factors, shocks and other details including income and expenditure.

After the baseline on livelihoods, the SIA presented a cross-referenced baseline on ecosystem services. The SIA team asked ecologists to plot species providing services against uses amongst affected communities. This section also described responses to household surveys about the contribution of natural resources to livelihoods and which resources were consumed or traded.

SIA Significance

Using the baseline data and the relative importance of various natural resources amongst affected communities, the SIA team then considers how pre-construction, construction, operation and decommissioning of the project will cause social changes from the pre-project baseline. Typical activities that could lead to economic impacts and displacement include land acquisition or land use rights transfer (and related loss of farmland, crops, trees, and access to other natural resources); increased use of concrete leading to erosion and surface runoff; water extraction; reduction of river flow caused by large dams; and effluent and warm water discharge.

Assessing the significance of impacts involves reflection on the sensitivity of affected communities based on concepts of vulnerability and resilience; essentially their capacity or lack thereof to absorb changes caused by the project. If an ecosystem service is assigned as a priority (see World Resource Institute methodology at beginning) then it is considered a highly sensitive receptor. Significance is assigned adverse or beneficial and then major, moderate, or minor according to the interaction between sensitivity and magnitude of the impact. Impact magnitude is based on likelihood, duration, extent, reversibility, and its effect on wellbeing. Subsequently, mitigation and management for significant (moderate and major) adverse impacts and, as best practice, enhancement measures for any beneficial impacts need to be incorporated into the project's environmental and social management plan.

A key methodological issue that must be addressed through the ESIA manager is whether and how other aspects of the ESIA, such as sections on ecology or resettlement, also consider the same impacts identified within the ecosystem services and livelihoods assessment. Double counting must be avoided.

SIA Mitigation and enhancement

Mitigation of livelihood impacts is addressed as part of an SIA and within resettlement planning. Focus in the SIA process is on protecting or replacing lost provisioning services. Protection happens at project design and at impact mitigation by adjusting the location, or modifying project infrastructure. Examples are:

- producing Biodiversity Action Plans
- including clauses in the Workers' Code of Conduct about not poaching animals, cutting trees, or setting fires
- information in worker and visitor inductions about movement restrictions or respect in areas where livelihoods rely on forestry products
- adding fish ladders to dams
- ensuring replacement (and more) of lost trees
- careful consideration of water supply, irrigation needs, tourism uses, navigation, fish ladders and flood management in development of hydropower projects

Project benefits are usually incorporated into the design or the SIA after a request from the developer, government, or lender. They can also be a response to needs identified in the local community, such as employment training for the whole community.

Resettlement action plans (RAPs) or livelihood restoration plans (LRPs) are expected to restore the living standards of displaced people[2], if not improve them. Provisioning services losses are often overlooked in RAP and LRP preparation. Issues can arise when developers fail to calculate the actual impact of livelihood losses, do not consider loss of priority ecosystem services, or incorrectly calculate the value of lost livelihoods. See the Indonesia case study.

Case Study: Coal Fired Power Plant in Indonesia Almost all agricultural land available to three villages was acquired and access to fishing waters was restricted. However, the original measures included in the LRP were to increase agricultural production and provide fishing supplies, which were inappropriate. Identification of use of ecosystem services could have resulted in better livelihood restoration activities.

Further livelihood restoration activities included women-focused small businesses including tailoring, bag making and snack making. While the initiatives were well organised, the incomes generated were 10% of those earned previously through agriculture. A study of livelihoods and incomes could have enabled identification of improved livelihoods strategies.

Livelihood restoration provides an opportunity to improve displaced persons' conditions (see the Pakistan case study.) The mitigation measures in each LRP must reflect the specific context and affected community. Consultation is crucial for gaining community buy-in for the initiatives and improving chances of success. Training, particularly to encourage wise use of compensation, and skills development to provide access to employment, are common mitigation measures that are often well received by developers. Small business creation is another option and functions more sustainably if the developer also arranges the purchase of goods or services over the long term (as per the Indonesian case) and provides trainers and equipment.

Case Study: Hydropower Plant in Pakistan Livelihood restoration measures were proposed including: training; skills development; crop and health insurance; relocation packages including livelihood related items; and earthquake resistant housing designs. The project developer elected to adopt only the training and skills development components. While this was accepted by the lender, further actions could have enhanced livelihood outcomes for the affected households.

Other livelihoods strategies that can be considered in SIAs include:

- microfinancing
- small scale insurance policies
- productivity-enhancement such as agricultural efficiency through rural extension services
- scholarships for selected displaced persons

Conclusion

Social impact practitioners guided by good international practice, lenders' standards and professional values seek to put in place measures through SIA, social management plans, RAPS and LRPs that best address the adverse effects of projects and enhance or induce beneficial effects where possible. This paper has explored the linkages between ecosystem services and natural

[2] Either physically or economically.

resource-based livelihoods. Understanding the baseline is a critical part of predicting impacts. Livelihood restoration needs to involve recovering or replacing priority ecosystem services. Failing to understand the connections between losses of ecosystems services and livelihoods can lead to ineffective management strategies. Employing SIA processes that facilitate the participation of affected communities can lead to improved identification of livelihood management strategies, more safeguarding of natural resources needed for household well-being, reduced vulnerability, and better resilience to change amongst project-affected people. Robust SIAs that effectively address ecosystem services and their linkage with livelihoods support can help projects move ahead with more broad community support and fewer conflicts, saving project sponsors, the government and the communities time and money.

References: Department for International Development (United Kingdom). Sustainable Livelihoods Guidance Sheets. Available at: http://www.efls.ca/webresources/DFID_Sustainable_livelihoods_guidance_sheet.pdf

IFC Performance Standards on Environmental and Social Sustainability (2012) Available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/performance+standards/environmental+and+social+performance+standards+and+guidance+notes#2012

IPIECA and Association of Oil and Gas Producers (OGP) (2011) Ecosystem Services Guidance: Biodiversity and ecosystem services guide and checklists

Rowan, Marielle (2009) Refining the attribution of significance in social impact assessment, Impact Assessment and Project Appraisal, 27(3), September 2009, pages 185–191

World Bank Environmental and Social Framework: Setting Environmental and Social Standards for Investment Project Financing (2016) Available at: http://consultations.worldbank.org/Data/hub/files/consultation-template/review-and-update-world-bank-safeguard-policies/en/materials/the_esf_clean_final_for_public_disclosure_post_board_august_4.pdf

World Resources Institute (WRI), October 2013. Weaving Ecosystem Services into Impact Assessment. Available at: https://www.wri.org/sites/default/files/weaving_ecosystem_services_into_impact_assessment.pdf

May 25, 2017. Article written for the conference proceedings of and presentation at IAIA2017.

**All three authors are members of Mott MacDonald's Social Safeguards Team. The authors routinely undertake social impact assessments, social due diligence reviews, resettlement planning and construction monitoring of international infrastructure projects. Their contacts are Hannah.mills@mottmac.com; Marielle.rowan@mottmac.com; Marianne.lupton@mottmac.com

The role of UNDRIP in Canada's federal EA process

Analise Saely, Candace Anderson and Christina Mulvena
Canadian Environmental Assessment Agency

The Government of Canada has fully supported the principles of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), with the goal of renewing its relationship with Indigenous people in Canada and moving towards reconciliation[1]. In Canada, there also exists a constitutional duty to consult and, where appropriate, accommodate Indigenous groups whenever the Crown contemplates decisions that may adversely impact their rights. The rights articulated in UNDRIP are largely consistent with this constitutional protection, and as a starting point, position Canada well in meeting many of the principles contained within the Declaration. However there continue to be opportunities within the legal and policy frameworks where UNDRIP can be further embraced, in particular through the continual improvement of environmental assessment processes. Drawing from a combination of observation and practitioner experience, but not academic literature, this paper identifies opportunities and challenges with implementing UNDRIP specifically with respect to the consideration of Indigenous knowledge in environmental assessment, and how this knowledge supports decisions regarding major resource projects.

Related to Canada's commitments towards UNDRIP, a review of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) is underway. The authors of this paper acknowledge legislative and policy changes are being considered by a panel of independent reviewers that may result in improvements to how Indigenous peoples' voices can be better factored into the environmental assessment process. The focus of this paper is to highlight aspects of the existing federal environmental assessment process under the CEAA 2012, and their relationship with UNDRIP.

Context

In Canada, consultation is integrated in the environmental assessments of proposed major resource projects with the goal that Indigenous groups are adequately consulted and accommodated when the Crown makes a decision that may adversely impact their rights, such as a decision on the acceptability of the proposed project and subsequent regulatory permitting. For more than a decade, the integration of Indigenous consultation has been a policy objective of the federal environmental assessment process. This model is also used to fulfill several objectives as it relates to UNDRIP.

Throughout the environmental assessment process, opportunities are available for Indigenous groups to participate, provide their views on potential environmental effects of the proposed projects, choose whether to share their Indigenous knowledge that can inform both a decision regarding the significance of adverse environmental effects, and an assessment of the severity of impacts to rights. CEAA 2012 has sections that address how projects can affect Indigenous people's relationship with their landscapes and resources. The information collected and analyzed for the purposes of CEAA 2012 can go a long way

[1] http://eareview-examenee.ca/panels-terms-of-reference/

towards informing the federal government's duty to consult about potential impacts from a project on Aboriginal rights.

The federal Aboriginal Consultation and Accommodation Guidelines provide direction to federal government officials when assessing the legal requirements for Aboriginal consultation and accommodation. How the federal government works with Indigenous groups within the environmental assessment process, and how consultation is integrated in an environmental assessment, is however somewhat flexible and adaptive on a project-by-project basis. As the Government of Canada develops policies around the implementation of UNDRIP, and reviews federal environmental assessment processes, both opportunities and challenges associated with integrating UNDRIP into aspects of the federal environmental assessment process will emerge.

Indigenous Knowledge

Indigenous knowledge occupies an important role in environmental assessment. It can provide important baseline information, and help inform the assessment of environmental effects and the development of potential mitigation measures. Overall the integration of traditional knowledge can result in a more informed decision making process. However, consultation practitioners struggle with how to work within our existing framework to create a more respectful and inclusive process that allows for the better incorporation and realization of the potential power of this knowledge.

The biggest challenge that practitioners face relates to the lack of confidence that Indigenous groups have in the current federal environmental assessment regime. Indigenous groups are often concerned that the information they provide will not be appropriately respected, understood, incorporated and protected. As such, this situation creates further challenges associated with receiving and incorporating Indigenous knowledge, and resolving conflicts when Indigenous and western knowledge systems diverge – all within legislated timelines.

Existing tools can be built upon to include strengthened provisions for independent review panels, and possibly other entities, to better safeguard Indigenous knowledge. Indigenous groups, federal and provincial governments, and proponents can work in partnership through the environmental assessment process with agreed upon goals such as: increasing mutual understanding of issues, trying to resolve conflicts, improving an understanding of how projects could interact with their traditional landscapes and resources, and potentially impact their rights. Further, via enforceable conditions, the Minister of Environment and Climate Change Canada can issue a decision statement that requires proponents to undertake activities that would ensure the involvement of Indigenous groups in monitoring initiatives post environmental assessment. This can be seen as a more appropriate use of and respect for Indigenous knowledge, provide for the longer term involvement of Indigenous groups in decision-making with respect to their landscapes and resources, and better uphold the principles of UNDRIP.

Critiques

Some of the main criticisms heard from Indigenous people that relate to the limitations of environmental assessment and its application in a UNDRIP context include (but are not limited to):

- Indigenous governance structures, laws and customs can be eroded through the federal environmental assessment process;
- environmental assessments are often done through a Western science lens that does not adequately make room for, and sometimes devalues, Indigenous knowledge and worldviews;
- cultural, spiritual, and other intangible impacts are not acknowledged or appropriately addressed through the current process, which can result in inaccurate assessments;
- information pertaining to environmental effects is contained in siloes, and there is little ability to reflect a holistic understanding of rights and land uses as they relate to ecosystems and affected landscapes;
- decisions appear to be made without adequately considering future generations, including cumulative effects which are not adequately addressed in the current process; and
- tight timelines and inadequate funding restrict the ability of Indigenous people to participate meaningfully in the environmental assessment and decision making process.

Moving forward

Participation of Indigenous groups has greatly improved the quality and rigor of federal environmental assessments in Canada; it is anticipated that in the future, environmental assessment will continue to evolve and improve. It is understood that any options for further embracing UNDRIP in the environmental assessment process will require meaningful and substantive discussions with Indigenous groups about how the federal government can adjust its policy framework and associated processes regarding consultation.

From a practitioner's perspective, areas where further consideration can be given to better integrating UNDRIP in the operationalization of federal environmental assessment processes, and potentially address some of the criticism, might include:

- developing better tools that integrate Indigenous knowledge into environmental assessment processes, including the identification of potential environmental effects, establishing baseline data, assessment of environmental effects and associated mitigation measures;
- exploring the application of provisions within modern treaties or self-government and First Nations Land Management agreements that relate to environmental assessment,
- developing tripartite collaboration agreements between Indigenous groups, proponents and government, to improve partnerships in undertaking environmental assessments;
- developing policy in partnership with Indigenous groups on matters of concern within the environmental assessment process; and
- improving mechanisms for inter-governmental collaborations between federal, provincial, and/or territorial governments to address issues that implicate multiple jurisdictions and require collaborative decisions on accommodation.

Evolution of IA practice in São Paulo State

Luis E. Sánchez[1], Edgard O. Rinaldi[2]

Introduction

Since its inception, in the 70's, EIA has evolved and changed in response to drivers such as experiential learning, scientific advances and technological developments. While some aspects of practice seem to have improved (Landim and Sánchez, 2012), there are persistent shortcomings: poor data quality (Landim and Sánchez, 2012); low commitment level (Morgan, 2012); difficulties in applying best practices (Kågstrom, 2016); process streamlining (Bond et al, 2014); late public participation (Steinemann, 2001).

Enquirying at 30 years of EIA practice in São Paulo State, Brazil, this research aims to identify changes in EIA practice and explore its possible drivers. Considering the stock of 887 EIAs in the files of Cetesb, the State Environmental Agency, since EIA was adopted in 1987, mining projects were chosen for review because they represent a significant share of the total (36.3%) and are well represented across the whole time frame.

Methods

The research employed a qualitative approach, based on document review using content analysis. Out of the EIA database maintained by Cetesb, featuring 322 files related to mining projects, six cases were selected for review. For the selection of cases, the complete Cetesb EIA database was consulted to extract information on the files relative to mining projects. A spreadsheet was prepared containing data on proponent, year of filing, municipality, mineral, status (approved/rejected) and location. A two-stage filtering was used to select the cases. Firstly, only approved quarry projects were considered. Quarry projects were chosen because they represent an important class of projects assessed over the study period, are larger than other frequent projects (mostly sand and clay pits) and have more significant impacts. Although we use the term 'mining', there is virtually no metal mine active in the State, the extractive industry being represented by industrial minerals and aggregates. From this subset (quarries), the cases were selected to cover (1) the longest time spectrum possible; (2) different rocks; and (3) different locations and settings (urban or rural).

For each case, the whole series of EIA documents was reviewed. They comprise: (1) terms of reference (ToR), (2) environmental impact statement (EIS), (3) its supplements, (4) records of public hearings, and (5) review report. The non-technical summary was not included.

For each kind of document, a script containing questions was developed. Guidance for reviewing the EIS was adapted from literature (Lee et al., 1999; EC, 2001), using criteria employed by Landim and Sánchez (2012) for content analysis. For public hearing records, the questions prepared by Duarte et al. (2016) were adopted. For the other documents, a list of questions was prepared by the authors. The set of five scripts was tested in one case, modified as needed, and applied to the six cases.

For this research, content analysis was used to check text documents against research hypothesis about its contents. The reduction of the complexity of a text to a number of categories of analysis allows for replicable inferences (Krippendorf, 2004). Data collected was tabled and compared aiming at detecting regularities, temporal changes or innovations, in a longitudinal approach, in order to do comparisons over a long period, restricted to a particular context (Bauer, 2000).

Hypothesis about possible drivers of changes were drawn from the reviewed EIA literature and from the authors' experience with Brazilian EIA system. Furthermore, some suggestions for potential improvements were provided.

1University of São Paulo, Escola Politecnica - PMI, Av. Prof. Mello Moraes, 2373, 05508-900, São Paulo, Brazil

2Companhia Ambiental do Estado de São Paulo – Av. Prof. Frederico Hermann Jr., 345, prédio 1, 9° andar, 05459-900, São Paulo, Brazil

Results

From June 1987, when the first EIS was filed, up to December 2015, Cetesb records 322 files of mining projects. Considering the filtering criteria, 54 files passed the first filter and six were intentionally chosen. The main results from each of the documents reviewed were summarized and are shown in tables 2 to 6.

Table 1: Cases selected for research

#	Year	Proponent	Municipality	Rock	Setting	ROM (t/yr)
1	1990	Paupedra	Guarulhos	Granite	Urban	2,000,000
2	1992	Horizonte Novo	Ribeirão Branco	Limestone	Rural	360,000
3	1998	Iúdice Mineração	São Paulo	Granite	Urban	1,400,000
4	2003	CCRG	Ribeirão Grande	Limestone	Rural	1,450,000
5	2012	Votorantim Cimentos	Salto de Pirapora	Limestone	Rural	7,400,000
6	2013	Leão Engenharia	Jardinópolis	Basalt	Rural	1,200,000

R.O.M.: run of mine

ToR Results

Table 2: Main results from the analysis of Terms of Reference

Question	Case					
	1	2	3	4	5	6
Are there ToRs for the EIS?	No	No	Yes	Yes	Yes	Yes
How many pages does it have?	n.a.	n.a.	10	3	17	25
Were ToR prepared with public input?	n.a.	n.a.	No	?	No	No
Did any other public agency contribute to the ToR?	n.a.	n.a.	No	Yes	No	No
Do ToR feature guidelines for the baseline?	n.a.	n.a.	No	No	Yes	Yes
Do ToR feature guidelines for determining impact significance?	n.a.	n.a.	Yes	No	Yes	Yes
Do ToR feature guidelines for mitigation?	n.a.	n.a.	No	No	No	No
Do ToR require the assessment of cumulative impacts?	n.a.	n.a.	No	Yes	Yes	Yes
Do ToR feature guidelines for environmental management plans?	n.a.	n.a.	No	No	Yes	Yes

n.a. not applicable ? unknown due to incomplete records

Public Hearing Results

Table 3: Main results from the analysis of Public Hearings Records

Question	Case					
	1	2	3	4	5	6
Did a public hearing take place?	?	?	Yes	Yes	Yes	Yes
Did the public hearing bring new information about the project?	n.a.	n.a.	Yes	No	Yes	No
Is there evidence of public opinion expressed at the hearing being considered in the EIS review?	n.a.	n.a.	Yes	No	Yes	Yes
Did it result in any project change, complements to the EIS or further commitment in Review Report?	n.a.	n.a.	No	No	Yes	Yes

n.a. not applicable

EIS Results

Table 4: Summary EIS contents

Question	Case					
	1	2	3	4	5	6
Number of professionals in the team	19	12	23	47	61	23
Number of pages of the EIS	189	47	411	815	729	505
Are there comparisons of locational and technological alternatives?	No	No	No	Yes	Yes	No
Is the project and its operational activities described?	Yes	Yes	Yes	Yes	Yes	Yes
Are the criteria used to determine the study areas in accordance to what is asked in the ToR?	n.a.	n.a.	n.a	Yes	ToR cites legal requirements	
Are the topics of the physical environment described in accordance to the ToR?	n.a.	n.a.	No	No	Yes	Yes
Are there primary data for physical environment baseline?	Yes	Yes	Yes	Yes	Yes	Yes
Are there primary data for fauna baseline?	Yes	Yes	Yes	Yes	Yes	Yes
Are there primary data for vegetation baseline?	Yes	Yes	Yes	Yes	Yes	Yes
Is there an integrated landscape analysis?	No	No	No	No	Yes	No
Does the EIS identify and locate the protected areas located inside the study area?	No	No	No	Yes	Yes	Yes
Were surveys (e.g. questionnaires, interviews) undertaken with affected communities?	No	No	Yes	Yes	Yes	No
Does the baseline identify vulnerable people?	Yes	No	Yes	Yes	Yes	No
Is there information on archaeological sites?	No	No	No	Yes	No	Yes
Are there formal impact predictions (e.g. modelling)?	Yes	Yes	Yes	Yes	Yes	No
Are baseline data explicitly used in support of impact prediction?	Yes	Yes	Yes	Yes	Yes	No
Does the EIS consider cumulative and synergic impacts?	No	No	Yes	Yes	No	No
Does the EIS assess impact significance?	No	No	No	Yes	Yes	Yes
Are the most significant impacts scheduled to be monitored?	n.a.	n.a.	n.a.	No	Yes	No
Do environmental management programmes state intended outcomes and indicators to evaluate achievement of goals?	No	No	No	No	No	No
Does the proposed monitoring include parameters, procedures, schedules, etc.?	No	No	No	Yes	No	No

n.a. not applicable

EIS Supplement Results

Table 5: Main results from the analysis of the EIS Supplement

Question	Case					
	1	2	3	4	5	6
Did the Agency require the EIS to be supplemented?	No	Yes	Yes	Yes	Yes	Yes
Did the Agency require supplemental data, in addition to what was requested in the ToR?	n.a.	n.a.	No	No	Yes	Yes
Did the Agency reiterate the request of EIS Supplement due to unsatisfactory information presented?	n.a.	No	Yes	Yes	Yes	Yes

n.a. not applicable

Review Report Results

Table 6: Main results from the analysis of the EIS Review Reports

Question	Case					
	1	2	3	4	5	6
How many pages does it have?	15	12	37	71	44	35
Does it request any commitment from the proponent due to the public hearing?	n.a.	n.a.	No	No	Yes	Yes
Are there technical requirements about alternatives?	n.a.	n.a.	n.a.	No	No	No
Was any impact considered as significant in the EIS not reviewed?	n.a.	n.a.	n.a.	No	No	No
Does the Review Report recommend any additional mitigation as compared to those proposed in the EIS and its supplement?	No	No	Yes	Yes	Yes	Yes
Does the Review Report recommend any additional environmental management programme?	No	No	No	Yes	Yes	Yes
Does the Review Report establish conditions for project follow-up?	Yes	No	Yes	Yes	Yes	Yes

n.a. not applicable

Discussion and conclusions

The preparation of ToR became mandatory in December 1994. In the reviewed cases, their structure and contents are not uniform and their size varies from 3 to 25 pages. The more detailed ToR set forth guidelines for baseline, impact significance determination and environmental management. Besides regulatory change, accumulation of experience may have influenced these changes (Morgan, 1998).

Public hearings became more important and influential over time in the reviewed cases. Opinions and requests from the public were explicitly considered in the EIS review in the more recent cases, evidenced by the finding that the Review Reports requested commitments from the proponent resulting from questions raised at the public hearings. Examples include, in case 5, support to traditional communities, additional environmental management programmes for monitoring air pollution and noise, and its follow-up, and a programme for supporting local labor. In case 6, it includes biodiversity offsets. Despite improvements, the documents contained no evidence of more advanced stakeholder engagement (IAP2, 2007).

The research also documented changes in the contents of EIS. Over time, they became larger and a higher number of professionals took part in their preparation, confirming findings of Landim and Sánchez (2012). The most recent EIS, however (case 6), is an exception, as it does not comprise advances observed in other recent EIS, especially case 5. Some observed advances can be attributed to legislation, like the consideration of potential impacts on protected areas located in the project surroundings (due to a law passed in 2000) and archaeological studies (due to new regulations in 2003), both found from case 4 onwards. Other advances, like surveys (mainly interviews) undertaken with affected communities, found from case 3 onwards (except case 6, as described before), may be due to mandatory ToR, more regulation (Landim and Sánchez, 2012) and experience accumulation (Morgan, 1998).

Project description, use of primary data on physical and biotical baseline, methodologies of impact assessment and use of data from baseline in support of impact prediction and assessment were recurrent practices, but became more detailed since ToR were adopted and as a result of more detailed guidelines over time.

Some sporadic evolutions, like landscape analysis, were found (case 5), but did not become recurrent practice and cannot be considered as advances, with baseline remaining descriptive with no new approaches (Landim and Sánchez, 2012). Other changes, like,

consideration of cumulative impacts (cases 3 and 4), monitoring of significant impacts (case 5) and more detailed environmental programmes (case 4, but without statement of goals and indicators) were also sporadic.

The Environmental Agency required all EIS, except case 1, to be supplemented. The driver of such request is either deficiencies found during EIS review or gaps identified in the public hearing or during the site visit conducted by the Agency's officers.

Review Reports also became larger and more detailed over time and include more commitments from the proponents, as well as recommend additional mitigation and environmental programmes. Conditions for project follow-up were usual practice. Experience accumulation may also be cited as a possible reason for such changes (Morgan, 1998, 2012).

Considering the findings, potential improvements of current practice comprise: changes of Agency procedures, such as early public consultation and mandatory site visit during the scoping phase; adoption of guidance procedures for scoping and EIS review; development of guidance on cumulative impact assessment and requiring systematic use of indicators for outcome-based environmental programmes.

References

BAUER, M.W. **Qualitative researching with text, image and sound: a practical handbook**. London: Sage. 2000.

BOND, A.; POPE, J.; MORRISON-SAUNDERS, A.; RETIEF, F.; GUNN, J.A.E. Impact assessment: Eroding benefits through streamlining? **Environmental Impact Assessment Review**. v. 45, pp. 46-53. 2014.

EC, European Commission. **Guidance on EIA: Scoping**. Luxembourg: Office for Official Publications of the European Communities, 2001.

DUARTE, C.G.; FERREIRA, V.H; SÁNCHEZ, L.E. Analisando audiências públicas no licenciamento ambiental: quem são e o que dizem os participantes sobre projetos de usinas de cana-de-açúcar. **Saúde e Sociedade**. v. 25, n. 4, pp. 1075-1094. 2016.

IAP2 – INTERNATIONAL ASSOCIATION FOR PUBLIC PARTICIPATION. IAP2 **Spectrum of Public Participation**. 2007. Available: https://c.ymcdn.com/sites/www.iap2.org/resource/resmgr/imported/IAP2%20Spectrum_vertical.pdf. Access on 06/23/2016.

KÅGSTRÖM, M. Between 'best' and 'good enough': How consultants guide quality in environmental assessment. **Environmental Impact Assessment Review.** v. 60, p. 169-175, 2016.

KRIPPENDORFF, K. **Content analysis: an introduction to its methodology**. Thousand Oaks, CA: Sage. 2004.

LANDIM, S.N.T.; SÁNCHEZ, L.E. The contents and scope of environmental impact statements: how do they evolve over time? **Impact Assessment and Project Appraisal**. v. 30, n. 4, pp. 217-228. 2012.

LEE N., COLLEY R., BONDE J., SIMPSON J. Reviewing the quality of environmental statements. **Occasional Paper** 55. Department of Planning and Landscape, University of Manchester.1999.

MORGAN, R.K. **Environmental impact assessment: a methodological perspective**. Dordrecht: Kluwer Academic. 1998.

MORGAN, R.K. Environmental impact assessment: the state of the art. **Impact Assessment and Project Appraisal**, v. 30, n. 1, p. 5-14, 2012.

SÁNCHEZ, L. E. **Avaliação de impacto ambiental**: conceitos e métodos. 2nd ed. Oficina de Textos, 2013.

STEINEMANN, A. Improving alternatives for impact assessment. **Environmental impact**

Assessment Review. v. 21, p. 3-21, 2001.

HYDROELECTRIC SWELL AND PROTECTED AREAS IN AMAZON

Marco Aurelio Santos

Introduction

Brazil has the largest number of protected areas, sheltering in its territory 12 % of the global total (WDPA, 2016). National Register of Conservation Units of Brazil (MMA, 2016) show that in 2016, Protection Areas (PAs) covered 18.5% of the Brazilian territory, corresponding to 158.2 million hectares with 73.6% of this total in the Amazon biome. Of these areas, 35% correspond strictly protected[1] and 65 % sustainable use[2].

The creation of conservation areas is extremely positive, because they ensure, among other benefits, maintenance of the germplasm bank and water flow for human consumption (Medeiros et al., 2011) as well as the conservation of natural resources. In addition, they are also one of the policy pillars of deforestation reduction in the region.

Despite all previously mentioned advantages, the maintaining of conservation areas is potentially conflictive with infrastructure works. One of the main conflict scenarios is associated with hydroelectric power plants (HPP) expansion in the Amazon.

Some mechanisms that are being used by the government to enable HPPs that affect the land itself are conservation area boundary redefinition, re-categorization or Removal of legal status. The objective of this study is to analyze the use of these instruments and verify how they are being applied in Brazil, especially those related to hydroelectric plants in the Amazon.

Protected areas change of legal status, excisions, rescissions and energy use

Changes of legal status of protected areas can occur in several ways. In order to define this phenomenon, Mascia & Pailler (2011) used a term called PADDD (*Protected Areas Downgrading, Downsizing and Degazettement*).

i. *Downgrade* is a decrease in legal restrictions on the number, magnitude, or the extent of human activities within a protected area, which can occur when an area changes its category from a more restrictive to a less restrictive;
ii. *Downsizing* refers to a protected area size decrease, as a result of land or sea area exclusion through a legal limit change, and finally;
iii. *Degazettement* is defined as an entire area legal protection loss.

Currently, electricity obtained from renewable sources in Brazil represents more than 78% of domestically produced energy, according to the Ten Year Plan for Energy Expansion 2024 (PDE) data (EPE, 2015). Of these sources, a large part comes from hydroelectric sources (65%).

The Amazon River watershed, home of much of the Brazilian hydroelectric unexploited potential, is where the country's hydro expansion is concentrated (Matos et al., 2011; Finer & Jenkins, 2012; Andrade & Santos, 2015), both in number of projects and in terms of installed capacity. For the 2014-2023 period, 92% of the expected power is located in the Amazon River watershed.

Figure 1 shows the restricted use area polygons (Indigenous Lands and Protected Areas) and the hydropower projects listed in the PDE 2023. It is noticed that many projects, such as

[1] Strictly protected areas have the function of maintaining ecosystems free of changes caused by human interference, only admitting its natural attributes indirect use (Brasil, 2000).

[2] The basic objective of Sustainable Use Units is to harmonize nature conservation with the sustainable use of a portion of its natural resources (Brasil, 2000).

Paredão A, Ferreira Gomes, Cachoeira Caldeirão, São Luiz do Tapajós and Jatobá power plants are either within protected area limits, or their future reservoirs will be limited by protected areas, which can be considered an additional conflict factor in project planning.

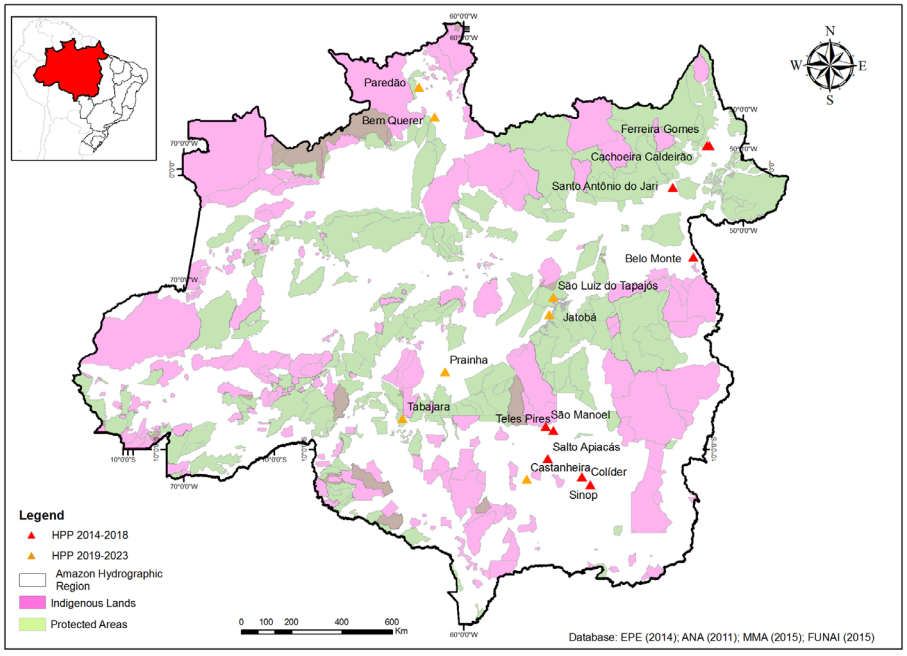


Figure 1. Proposed hydropower plants in the PDE 2023 and restricted use areas.

As already mentioned, electricity production and transmission are among the main causes of changes in protected areas. As there is no hydropower project installation legal prerogative in protected areas, particularly those strictly protected, an alternative to enable projects is to remove their legal protection and restrictive use status of areas that would be occupied by plants.

In recent years, legal acts in Brazil changed the boundaries of protected areas to facilitate the licensing of power generation projects. The 2010-2016 period accounted for 74.1% of PADDD events.

The compilation of some changes in protected areas boundaries due to energy uses in Brazilian Amazon twenty-three projects (Figure 2) until the year 2016, ten are related to limit reduction of the land area protected (downsizing), eleven were associated to the loss of legal protection (degazettement) and two projects are associated to area redefinition (expansion with area inclusion and exclusion). In some cases during the PADDD process, was changed areas of increase in units or creation of new protected areas to offset the losses.

The compilation of some changes in protected areas boundaries due to energy uses in Brazilian Amazon twenty-three projects (Figure 2) until the year 2016, ten are related to limits reduction (downsizing), eleven to revocations (degazettement) and two to area redefinition (expansion with area inclusion and exclusion). In some cases during the PADDD process other áreas were increased or added to offset losses due to PADDD.

However, the PADDD process resulted in a residual deficit with the total altered areas sum 1,613,024 ha, total added areas sum 993,959 ha. The deficit of area losses is certainly one of the arguments used in opposition to such action. Noteworthy is the creation of Maués Ecological Station as compensation for the loss of federal protected areas occurred in 2012 in the Tapajós basin, state of Pará.

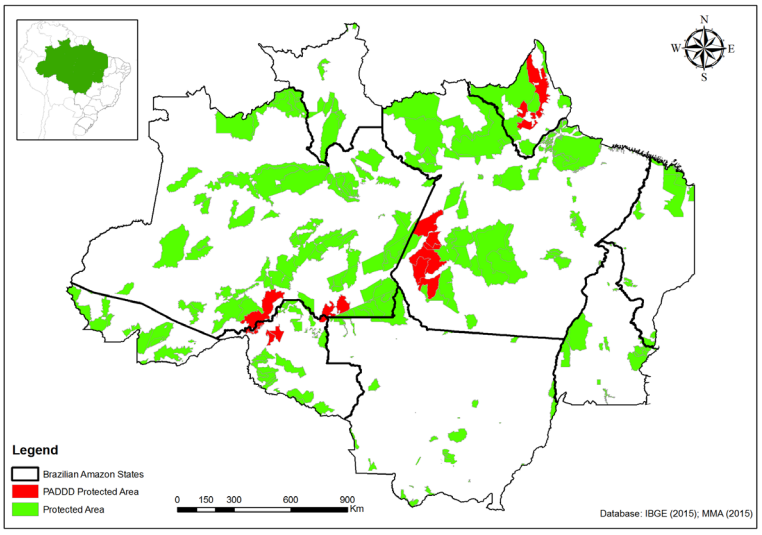


Figure 2. PAs in Amazon, with emphasis on the altered for the production of energy

PADDDs: Causes and consequences

In Brazil, two justifications most widely used for the occurrence of downsizing are legal and economic character. In the legal case, the management institutions of protected areas are reluctant to accept the preparation of environmental studies in strictly protected areas because these units do not allow direct use of their resources.

In this context, Bim (2015) states one of the reasons that discredit the view, that the authorization to carry out the studies is not possible from a legal point of view, lies in the fact of Law 9,985/2000 to restrict various activities in the areas of full protection, limited basically to the research and/or education. The environmental study, although geared to subsidize the environmental licensing process, is a type of research, and can provide important data that would make it possible to identify the exact extent of the damage to the PA, enabling an informed policy decision to maintain the PA or to reduce it.

From an economic perspective, hydroelectric plants have investments that reach billions of dollars, in this case legal protection is rearranged to given for the entrepreneur who wants to invest in the project. Regarding this issue the downsizing appears as an instrument to increase the attractiveness of the project to the extent that it will not directly affect protected areas where licensing, in the case of strictly protection area, cannot occur.

The main issue is that previous downsizing, without knowing the environmental feasibility of the project, is usually harmful. A recent case in this regard was the licensing of the hydroelectric plant of Sao Luis do Tapajós (8,040 MW), located in the state of Pará. For possible environmental and feasibility studies two protected areas (Amazon National Park, Itaituba II National Forest) were were subject to degazzettement in 2012. However, in August 2016 IBAMA denied the previous license on the grounds of inconsistencies in the EIA and the flooding of indigenous land in the demarcation borders. Since the process of downsizing, more than four years have gone and the project has not been licensed.

The protected area losses stimulate increased degradation and deforestation. Accordingly, Martins et al. (2014) research evaluated the deforestation in 10 areas that have lost legal protection between 2003 and 2011. This analysis was considered over a period of 10 years, five years before and five years after changes occurred. An evaluation was performed regarding the rate of deforestation in the area, which have suffered loss, or reduction of legal protection in the remaining

areas and around (a distance of 10 kilometers from the boundaries of the protected area before the loss or reduction of legal protection was considered).

Another research study from WWF (2014) showed that between 2000 and 2012, areas that have lost their protected status recorded deforestation rates 18 times higher than the protected areas in general, and 2.65 times higher than regions that were never protected. Forrest et al. (2014) on analysis of areas that suffered PADDD in Peru and Malaysia found that these regions suffered high deforestation and loss of carbon.

During the analysis of case studies PADDDs finds a set of critical problems present in most publications (Gouveia & Sena, 2012; INESC, 2012; Omoto, 2012; Bertrand et al, 2014). Some of them were: reduction of protected areas; lack of technical study that supports disaffection; lack of consultation with affected populations; no study to prove the technical feasibility, economic and environmental HPP; short term deadlines to conduct the legal instrument that defines the disaffection, limiting debate and possible improvements.

Conclusions and recommendations

Processes involving PADDD by generating as Downgrading, Downsizing and Degazettement in protected areas are not highly regarded by society in general. Actually, alternatives provided by governmental agencies could be taken better into account by stakeholders. In many cases, PADDD events are detrimental to biodiversity conservation. Thus, upon the occurrence of these events, conservation and environmental management instruments should be used to mitigate and compensate area losses.

A balanced solution has to be reached using political apparatuses and conflict management techniques. Regarding the legal aspect, it is understood that it is not reasonable to involve PADDDs in order to carry out surveys for the preparation of studies of environmental and socioeconomic impact in the Protected Areas because, these same studies, as stated by Omoto (2012) and Bim (2015), can identify the exact damage to the PAs and will support a proper political decision to keep or to downsize these areas.

Thus, some measures are proposed here:

i. The downsizing process should be based on technical and environmental studies coordinated by those management institutions responsible for protected areas, ensuring popular participation. The proper use of the excluded area, to ensure that the activities or occupations developed does not affect the biota of protected areas, with clear rules that reconcile the use and protection of ecosystems.

ii. The case of downgrading protected areas should be supported by a study verifying the new classification.

iii. The areas considered should prioritize the connection with other protected areas fostering the formation of ecological corridors.

iv. The PADDD instrument should only be adopted together with proof of the technical, economic and environmental impact of the project.

v. The reincorporation of area losses, which have not been effectively occupied by the project, is another prerogative that should be present in the normative acts, which authorize the downsizing or resettlement. This would be a priority consideration as environmental and feasibility studies indicate in areas that are without legal protection tend to be more vulnerable to harmful activities like deforestation.

Brazil's good hydric potential and natural richness potential, such as the biodiversity of the Amazon region, cannot be discarded. If a solution is reached in due time, it will be possible to

implement good hydroelectric projects and create environmental compensatory mechanisms far beyond what is expected today in Brazil's specific legislation.

References

Andrade A, Santos M (2015) Hydroelectric plants environmental viability: Strategic environmental assessment application in Brazil. Renewable and Sustainable Energy Reviews 52:1413–1423.

Bim E (2015) Licenciamento Ambiental. 2º ed. Lumen Juris. 522p.

Bernard E, Penna L, Araujo E (2014) Downgrading, downsizing, degazettement, and reclassification of protected areas in Brazil. Conservation Biology, Vol. 28, n° 4. 939-950.

EPE - Empresa de Pesquisa Energética (2014) Plano Decenal de Expansão de Energia 2023. 434 p. Brasília.

Finer M, Jenkins C (2012) Proliferation of hydroelectric dams in the Andean Amazon and implications for Andes-Amazon connectivity. PLoS ONE. Vol.7. n.4.

Forrest J, Mascia M, Pailler S, Abidin SZ, Deza Araujo M, Krithivasan R, Riveros J (2014) Tropical deforestation and carbon emissions from protected area downgrading, downsizing, and degazettement (PADDD). Conserv. Lett. 8, 153–161.

Gouveia J, Sena E (2012) Carta Aberta sobre Irregularidades da Medida Provisória nº 558/2012.

INESC - Instituto de Estudos Socioeconômicos (2012). MP 558 é aprovada Available at: http://www.inesc.org.br/noticias/noticias-do-inesc/2012/maio/mp-558-e-aprovada, Accessed in January 2016.

Martins H, Araújo E, Vedoveto M, Monteiro D, Barreto P (2014) Desmatamento em Áreas Protegidas Reduzidas na Amazônia. Belém-PA: Imazon. Available at: <http://www.imazon.org.br/publicacoes/outros/desmatamento-em-areas-protegidas-reduzidas-na-amazonia>. Accessed in February 2015.

Mascia M, Pailler S (2011) Protected area downgrading, downsizing, and degazettement (PADDD) and its conservation implications. Conservation Letters 4, 9 -20.

Matos F, Camacho J, Rodrigues P, Sebastião C, Guimarães Jr S (2011) A research on the use of energy resources in the Amazon. Renewable and Sustainable Energy Reviews 15: 3196– 3206.

Medeiros R, Young C, Pavese H, Araújo F (2011) Contribuição das unidades de conservação brasileiras para a economia nacional: sumário executivo. Brasília-DF: UNEP-WCMC, 44p.

MMA-Ministério do Meio Ambiente (2007) Secretaria da Biodiversidade e Florestas. Áreas prioritárias de conservação, uso sustentável e repartição da biodiversidade. Atualização – Portaria MMA nº 9, de 23 de janeiro de 2007.

MMA-Ministério do Meio Ambiente (2016). Cadastro Nacional de Unidades de Conservação Available at: <http://www.mma.gov.br/areas-protegidas/cadastro-nacional-de-ucs>. Accessed in December 2016.

Omoto J (2012) Audiência pública sobre as hidrelétricas e as unidades de conservação na Amazônia - o caso da Usina Tapajós, no Pará. Câmara dos deputados. 55p. Brasília.

WDPA-World Database on Protected Areas (2016) Statistic UNEP/WCMC/IUCN/WCPA. Available at:<www.wdpa.org/statistic.aspx>. Accessed in December 2016.

WWF-Word Wildlife Fund (2014) Desmatamento em áreas que perderam a proteção cresce na Amazônia. Available at: <http://www.wwf.org.br/?42224>. Accessed in August 2015.

Looking to the Future to Protect the Past: Managing the Effects of Climate Change and Sea Level Rise on Archaeological Sites at Fort Eustis, Newport News, Virginia.

Abstract ID No. 100

Scott K. Seibel, RPA
AECOM
12420 Milestone Center Drive, Suite 150
Germantown, MD 21702 USA
scott.seibel@aecom.com / 301-820-3145

Introduction

Global climate change poses myriad threats to coastal and riverine cultural heritage, which encompasses a range of categories such as, but by no means limited to, archaeological sites, underwater shipwrecks, historic buildings, paintings, and oral traditions. Perhaps the most pressing threat to tangible cultural heritage such as archaeological sites and historic buildings is erosion resulting from sea level rise, increased tidal range, flooding from increased rainfall, and intensifying storm surges. These erosive forces are increasing the rate of shoreline retreat, undermining buildings and structures, and eroding cultural heritage, a problem that will become more acute over the next few decades. The scope of this problem is international and grows more concerning as climate change intensifies. As Erlandson (2008:168) notes, "if left unchecked, rising seas, accelerated erosion, and larger and more frequent megastorms will destroy many of the world's most important coastal…sites."

A United Nations Educational, Scientific, and Cultural Organization (UNESCO) study of coastal World Heritage Sites estimated that of the 720 cultural and mixed (i.e., cultural and natural) sites listed as of 2014, 136 sites would be directly impacted by sustained sea level rise (2.3 meters per degree of global mean temperature increase) over the next 2,000 years (Marzeion and Levermann 2014). Other studies have underscored the threats to heritage around the world, including a 2015 report by the United States National Park Service (NPS) that noted more than 3,900 NPS assets valued at over $40 billion are highly vulnerable to erosion (Peek et al. 2015). These figures do not include the likely hundreds of thousands of cultural heritage sites, known and unknown, in threatened areas of the United States, let alone globally. These studies, among many others, demonstrate a necessity for effectively planning for climate change impacts to cultural heritage.

Planners and designers of coastal and riverine facilities are increasingly factoring in the potential long-term impacts of climate change to ensure that projects are designed in such a way to protect costly investments. However, impact analyses often focus on the direct effects to cultural heritage resulting from project construction or short-term preservation measures implemented within the first few years of the analysis. If a project is engineered to withstand potential impacts from things such as sea level rise, should not the preservation and mitigation methods for cultural heritage be similarly designed?

The preservation of cultural heritage does not stop at project completion, but must be extended throughout the use-life of a project. The question then becomes, how we can factor the threats from climate change into impact assessment, project planning, and design, to better protect cultural heritage (and other important resources) over the long-term, not just during project construction?

This paper will focus on a case study from a U.S. military installation, Joint Base Langley-Eustis, in Tidewater Virginia. For the study, AECOM assessed 31 threatened archaeological sites, and then made recommendations regarding site significance and long-term planning and mitigation for each site, as appropriate.

Fort Eustis Archaeological Site Management Study

The study of short- and long-term erosion threats to archaeological sites at Fort Eustis used methods that can be applied to other coastal and riverine cultural heritage affected by direct or indirect effects of climate change.

Fort Eustis, part of Joint Base Langley-Eustis, is located on Mulberry Island, technically a peninsula bounded by the Warwick River on the east and the James River on the south and west (Figure 1). Both rivers are tidally influenced, and the James River enters the Chesapeake Bay approximately 30.5 kilometers downstream. Due to Mulberry Island's low elevation, especially the southern two-thirds where most of its known archaeological sites are located, it is extremely vulnerable to the threat of sea level rise and erosion. Currently, dozens of archaeological sites at the base are experiencing erosional damage, including sites where human remains have been found protruding from erosional scarps.

United States federal agencies are subject to Section 110 of the National Historic Preservation Act, the intent of which is to ensure agencies manage the cultural resources on their lands and integrate historic preservation into their overall program goals. This includes establishing preservation programs and ensuring that historic properties under their jurisdiction are sufficiently managed and maintained.

To meet the installation's short- and long-term planning needs and their regulatory obligations, the Fort Eustis Cultural Resources Management Program implemented a study of the effects of shoreline erosion on the 31 threatened archaeological sites. The interdisciplinary study involved archaeologists and coastal engineers from AECOM. The ultimate goals of the study were to provide an evaluation of current and long-term threats to the archaeological sites as well as provide a variety of management options that base planners could implement to protect or mitigate these threats.

The Fort Eustis Cultural Resources Manager identified threatened sites as those being vulnerable to environmental and erosional processes such as rainfall runoff, daily tidal cycles, and storm surges, both in the short- and long-term as exacerbated by global climate change and sea level rise. The study examined the historic, present, and possible future states of erosion for archaeological sites with a focus on severity, rate of destruction, and loss of information in order to develop comprehensive risk assessments and potential management strategies that take into

consideration the spectrum of site types, their prospective research value, potential and active threat statuses, and resource management objectives.

A desktop analysis was first conducted that reviewed existing aerial imagery, erosion analyses, and sea level rise and storm surge inundation projections to evaluate the potential impacts of coastal erosion on the selected archaeological sites. Among the data sets included in the analysis were Virginia Institute of Marine Science coastal data layers (Berman et al. 2012), the United States Army Corps of Engineers' Sea-Level Change Curve Calculator (version 2015.46; Huber and White 2015), and the Federal Emergency Management Agency Flood Insurance Study for the City of Newport News, Virginia (FEMA 2014). A field assessment supplemented the digital data and included the documentation of bank erosion, shore accretion and sediment transport, beach conditions, evidence of human and animal impacts, and archaeological observations, such as eroding artifacts.

Using the digital and field data, a scoring system was established for the project-rated historic erosion rates, shoreline stability, current erosion threats, and future erosion and inundation threats with low and high sea level rise projections within the next 5, 10, 20, and 50 years. The present erosion threat was determined based on the amount of erosion viewed during the field reconnaissance, and the future erosion threat was determined based the high sea level rise scenario and the distance of cultural resources from the shoreline. The wave hazard threat was established based on fetch (the length of water over which wind blows) and exposure to open water. Twenty-nine of the 31 archaeological sites are experiencing on-going erosion, including observed loss of archaeological deposits, with some projected to be completely inundated within 50 years based on high sea level rise projections.

Site-specific erosion mitigation options were developed using information regarding present and future erosion, existing marsh features and other vegetative buffers, wave hazard, and knowledge of available and practical shoreline protection methods. Options provided for each site included a variety of erosion control measures such as oyster reefs, living shorelines, geotextile tubes, and hardening (e.g., rip-rap) alone or combined with archaeological mitigation; no action was recommended for locations with low threat profiles.

In addition to the individual recommendations for archaeological and/or erosion control actions, management recommendations were presented regarding the integration of the site-specific recommendations into the Fort Eustis Cultural Resources Management Program. These recommendations have to be balanced with funding limitations and the larger mission of the installation and the United States Department of Defense, but they give the installation a road map to ensure that the management and protection of its cultural heritage is accounted for as it plans for its future.

This includes refocusing Section 110 efforts to conduct site significance evaluations for sites with a higher risk of eroding due to normal conditions, storm events, and projected sea level rise in order to determine if long-term erosion control measures are necessary. These efforts will be prioritized over site evaluations within low-threat areas that may be buffered from the effects of climate change for decades. Recommendations also included determining where short-term

erosion controls could be implemented to reduce the threat profile while the sites are integrated into a longer-term targeted program to assess their significance.

Recommendations

The methods used in the study are relevant to project-specific impact assessment to ensure the protection, preservation, and/or mitigation of cultural heritage from direct and indirect human or environmental effects resulting from sea level rise or project-related impacts. With more pro-active management and planning, the effects of global climate change and project impacts on coastal and riverine cultural heritage can be reduced, or in some cases eliminated.

Using available data sets, impact assessments can examine how various sea level rise projections in a project area could negatively affect the integrity of cultural heritage that otherwise is not directly impacted by project construction. That information can then be used to provide recommendations for project design that would help ensure cultural heritage can be protected and preserved following project completion. While the accuracy and granularity of available data is globally variable, even the use of simple data such as local topographic conditions and global sea level rise projections can provide useful and actionable information.

In relation to project-related effects, the methods for assessing direct impacts are routine and straight-forward. When it comes to assessing indirect effects, however, the methods are not so clear-cut. Development projects in riverine and coastal environments often result in altered currents, reduced permeable surfaces, wetland destruction, and channelization of drainages, all of which can threaten the long-term preservation of cultural heritage. Assessing indirect cultural heritage impacts requires a more holistic approach, integrating not just proposed engineering designs but also proposed changes to natural resources, such as the removal of vegetation or the planting of vegetative buffers.

Project planners should approach the mitigation of a project's direct and indirect impacts in a systemic sense, looking at impacted resources as a whole and how design and mitigation can positively and negatively affect different resource types, including how a negative for one could be a plus for another and vice versa. The time depth for a resource to feel those effects is also important, as some effects may be compounded over time or exacerbated as sea levels rise.

Modeling water flow and fetch can be used to identify locations where erosion may be increased or diminished, based on different project designs. Hardened construction, like a groin or seawall, can result in increased sedimentation in one area and increased erosion in another. This can have the effect of aiding the preservation of one cultural heritage object but facilitating the destruction of another. Planting shoreline vegetation, such as mangroves, may not only mitigate natural resource destruction from project implementation but also serve a role in preserving cultural heritage. Monitoring programs that last throughout the life-span of a development should be implemented to assess changing impacts to cultural heritage and provide remedies should preservation methods fail.

While global climate change threatens cultural heritage across the world, we can and should take steps to manage and mitigate the effects and we need to acknowledge that impact assessment has

a role and a responsibility in this. Even in our roles as client advocates, we are resource professionals and have an ethical duty to ensure that we are helping preserve important cultural heritage for future generations.

Figures

Figure 1. Project Location.

References Cited

Berman, M.R., H. Berquist, S. Killeen, C. Hershner, K. Nunez, K. Reay, T. Rudnicky, and D. Schatt
2012 *City of Virginia Beach, Shoreline Inventory Report, Comprehensive Coastal Inventory Program*. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia.

Erlandson, Jon M. and Torbin C. Rick
2008 *Human Impacts on Ancient Marine Ecosystems: A Global Perspective*. University of California Press, Oakland.

ESRI
2015 *ArcGIS Map Service, ArcMap 10.1*. ESRI, Redlands, California.

Federal Emergency Management Agency (FEMA)
2014 Flood Insurance Study for the City of Newport News, Virginia (Independent City). Washington, D.C., December 9, 2014.

Huber, Mark and Kate White
2015 Sea Level Change Curve Calculator (2015.46) User Manual. Electronic resource, http://www.corpsclimate.us/docs/Sea_Level_Change_Curve_Calculator_User_Manual_2015_46_FINAL.pdf, accessed January 22, 2016.

Marzeion, Ben, and Anders Levermann
2014 Loss of Cultural World Heritage and Currently Inhabited Places to Sea-Level Rise. *Environmental Research Letters* 9:1-7.

Peek, K.M., R.S. Young, R.L. Beavers, C.H. Hoffman, B.T. Diethorn, and S. Norton
2015 Adapting to Climate Change in Coastal National Parks: Estimating the Exposure of Park Assets to 1 m of Sea-Level Rise. National Resource Report NPS/NRSS/GRD/NRR–2015/961. National Park Service, Fort Collins, Colorado.

Seibel, Scott, Emily Dhingra, Ralph Koziarski, Peter Regan, Eric Palmer, Rebecca Aiken, Heather Zhao, and Bradley Krueger
2016 *Archaeological Site Management Study: Joint Base Langley-Eustis (Ft. Eustis), Newport News, Virginia*. URS Group, Inc., Germantown, Maryland.

United States Geological Survey (USGS)
1986 *Mulberry Island, VA*. 7.5-minute quadrangle. United States Geological Survey, Washington, D.C.

1994 *Yorktown, VA*. 7.5-minute quadrangle. United States Geological Survey, Washington, D.C.

HEAVY METAL IMPACT ON AQUATIC LIFE AND HUMAN HEALTH – AN OVER VIEW

Dr. Alkesh I. Shah
Associate Professor & Head, Zoology Department, B. P. Baria Science Institute, Navsari – 396445, Gujarat, India.
E mail: alkesh22a@gmail.com Mobile no: +91 9825456680

ABSTRACT: In the industrialization era, pollution has deteriorated the quality and diversity of aquatic life. Industries discharge their waste containing heavy metals into the water bodies. These heavy metals accumulate in different organs of the fish, causing mortality. This effect first appears in blood and affects the fish by alteration of blood components making the fish weak, anemic and vulnerable to diseases. Heavy metals pollution is thus targeting the major protein source in the form of fish. The exposures to heavy metals cause increase or decrease in hematological indices, with decline in protein and glycogen reserves. Therefore the impact of heavy metals was carried out on the fish *Labeo rohita*. Heavy metals affect the reticulo endothelial system and haematopoisis, changing osmotic resistance of erythrocytes. The red and white blood cells at different stages of the pathological process are subjected to quantitative and qualitative deformation.

Key Words: - *Labeo rohita*, industrialization, aquatic life, heavy metals, hematology.

INTRODUCTION:

Heavy metal toxicity has proved to be a major threat as several health risks are associated with it. These metals have hardly any biological role to play in the human body but on the contrary their toxic effect causes malfunctioning of the body system. These elements may sometimes act as pseudo elements of the body, interfering with the metabolic processes that occur in the body. They accumulate in the body resulting into chronic diseases. In order to maintain public health, measures have been taken to control and prevent by treating metal toxicity occurring at various levels like occupational exposure, accidents and environmental factors. Metal toxicity depends on the absorbed dose, its route as well as duration of exposure. These heavy metals bind with protein sites which are not meant for them, by displacing original metals from their natural binding sites causing malfunctioning of cells by their toxicity. Oxidative deterioration of biological macromolecules is primarily due to binding of heavy metals to the DNA and nuclear proteins. Industrial waste contain large number of toxicants such as salts of heavy metals, acids, organic matter, pesticides and even cyanides which deteriorate the physico-chemical characteristics of water. These pollutants build up in the food chain and are responsible for adverse effects and even death of the organisms in the aquatic system. Fish serve as biomarkers of environmental pollution as studies on the overall health are widely carried out in order to evaluate the physiological changes of aquatic ecosystems. Heavy metals are generally referred to as those metals which possess a specific density of above 5 gm/cm^3 and adversely affect the environment and living organisms. These metals are quintessential to maintain various biochemical and physiological functions in living organisms in very low concentrations only. These metals prove to be noxious when they exceed certain threshold concentrations. Heavy metals are significant environmental pollutants and their toxicity is a problem of increasing significance for ecological, evolutionary, nutritional and environmental reasons. The most commonly found heavy metals in waste water include **copper, nickel, zinc, cobalt** and **cadmium** all of which cause risks for human health and environment. Heavy metal toxicity can lower energy levels and damage the functioning of brain, lungs, kidney, liver and blood composition and other important organs. Long term exposure to high concentrations lead to gradual and progressive physical, muscular and neurological degenerative processes that initiate disease like multiple sclerosis, Parkinson's, Alzheimer's and muscular dystrophy. Repeated long term exposure of some metals and their compounds may cause cancer.

Copper:

Copper is a trace element which is essential for the function of specific protein enzymes. However, at high concentrations it is toxic to the organisms. The increasing industrial activities and the use of $CuSO_4$ as a fungicide in agricultural practices as well as in the control of algae and pathogens in fish culture ponds have increased the copper concentrations in aquatic systems. It is used in combination with lime and water as a protective agent[3]. Copper sulphate is very toxic to fish. Its toxicity to fish varies with the species and the physical and chemical characteristics of the water[9].

Nickel:

Nickel finds numerous applications in many industries because of its resistance to corrosion, high strength and durability, pleasing appearance, good thermal and electrical conductivity and its ability in forming alloys with other metals. The production of alloys accounts for approximately 75% of total nickel consumption[6, 7, 10]. The pathogenesis of nickel toxicity is relatively complex because of the large number of chemical and physical forms.

Zinc:

Zinc, an essential trace metal becomes toxic when in the nutritional supply it becomes excessive. The main uses of zinc are in the manufacture of galvanized iron, bronze, white paint, rubber, glazes, enamel glass, paper, as a wood preservative (ZnCl2, fungicidal action), petrochemicals, and fertilizers and in steam generation power plants[6]. Some zinc is released into the environment by natural processes, but most comes from activities of people like mining, steel production, coal burning, and

burning of waste. It attaches to soil, sediments, and dust particles in the air. Zinc compounds can move into the groundwater and into lakes, streams, and rivers. Most of the zinc in soil stays bound to soil particles. Moderately increased zinc concentrations in water also stem from the release of zinc from drainage pipes due to corrosion. It accumulates in fish and other organisms[4].

Cobalt:
Cobalt is found in meteorites. Elemental cobalt is a hard, silvery grey metal. However, cobalt is usually found in the environment combined with other elements such as oxygen, sulfur, and arsenic. Small amounts of these chemical compounds can be found in rocks, soil and plants, Cobalt metal is usually mixed with other metals to form alloys, these alloys are used in a number of military and industrial applications such as aircraft engines, magnets, and grinding and cutting tools. Cobalt compounds are used as colorants in glass, ceramics, and paints, as catalysts, and as paint driers. Cobalt colorants have a characteristic blue color; however, not all cobalt compounds are blue. Cobalt compounds are also used as trace element additives in agriculture and medicine.

Cadmium:
This metal was first used in World War I as a substitute for tin and in paint industries as a pigment. Today, it is also being widely used in rechargeable batteries, for production of special alloys, and is also present in tobacco smoke. About three-fourths of cadmium is used in alkaline batteries as an electrode component, the remaining part is used in coatings, pigments and in plating works and also as a plastic stabilizer. Humans may get exposed to this metal primarily by inhalation and ingestion and can suffer from acute and chronic intoxication.

Effect of heavy metals on humans:
There are 35 different metals that are of great concern for us because of residential or occupational exposure, out of which 23 are heavy metals, which are antimony, arsenic, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, gold, iron, lead, manganese, mercury, nickel, platinum, silver, tellurium, thallium, tin, uranium, vanadium, and zinc[5]. These heavy metals are commonly found in the environment and diet. In small amounts they are required for maintaining good health but in larger amounts they can become toxic or dangerous. As discussed earlier, heavy metal toxicity can lower energy levels and damage the functioning of the vital organs of our body.

Effect of heavy metals on aquatic life:
Fish is high in omega-3 and protein that the human body needs to stay healthy. However, potentially dangerous heavy metals are absorbed into the body tissues of fish that are transferred to humans on consumption of this affected fish. Good quality of food for human consumption can only be produced in an environment free from contamination and pollution. Fish are of great economic importance, but are affected immensely by various chemicals including heavy metals directly or indirectly in different ways. Several reports indicate high mortality of juvenile fish and reduced breeding potential of adults after long term exposure to heavy metals[8]. The freshwater fish, L*abeo rohita* is of great commercial importance because it is the most common fish widely consumed worldwide. Therefore, it can be a good model to study the responses to heavy metal contaminations. Histopathological studies on fish are a noteworthy and promising field to understand the structural organization occurs in the organs due to pollutants in the environment. These structural changes vary with the body parts, nature of the pollutant, medium and duration of exposure. Water quality characteristics also influence histopathological manifestations of toxic effects[2]. The structural changes in the organs at microscopic cellular and organ level leads to alterations of the function systems. Hence the main objective of this study is to provide insight into the source of heavy metals and their harmful effects on environment and living organisms.

METHODOLOGY:

Processing of the fresh water fingerlings major carp *Labeo rohita* for the study:

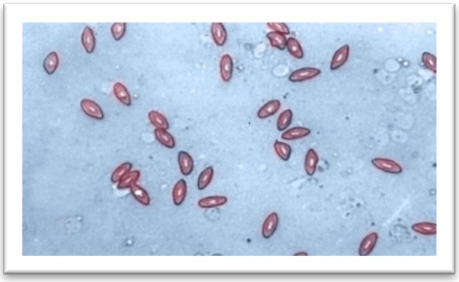
1) Live and healthy fresh water fingerlings major carp *Labeo rohita* of both sexes were collected from the local fish farms and kept as stock in O_2 saturated water at appropriate pH.
2) Commercial fish food was fed twice a day.
3) The fish were acclimatized to the lab conditions for a period of 15-20 days.
4) Different concentration in ppm of Zinc, Cadmium, Copper, Nickel and Cobalt were made by dissolving appropriate amount of analytical grade Zinc chloride, Cadmium chloride, Copper chloride, Nickel sulphate and Cobalt sulphate in the fresh water.
5) Amino acids were separated from the fish tissue using a centrifuge.
6) For qualitative and quantitative analysis of amino acids, 2-D ascending paper chromatographic technique was used.
7) Live and healthy fresh water fingerlings exposed to different concentrations of Zinc chloride, Cadmium chloride, Copper chloride, Nickel sulphate and Cobalt sulphate.
8) After exposing to different concentration and duration, 2–3 fingerlings were removed for blood smear study.
9) The thin blood smears were prepared for observing the cellular alterations in the blood cells. The smears were stained with Leishmann's stain and the observations were noted.

RESULTS AND DISCUSSION:

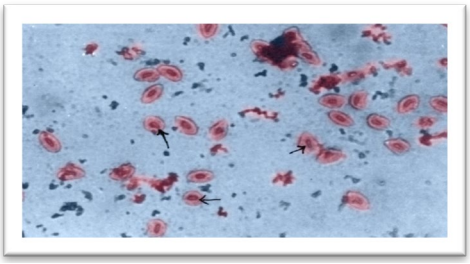
Hematological studies:

Effect of varying concentrations of heavy metal salts on normal blood cells of fish *Labeo rohita* exposed for 15, 30 and 45 days was studied. Following physiological changes in the fish were observed:

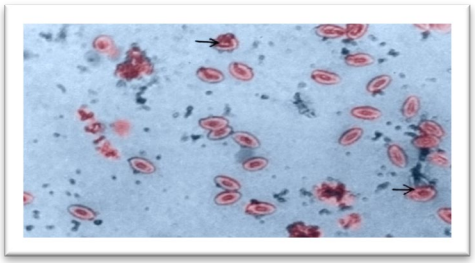
- Cell membrane may be wrinkled, damaged or totally destroyed.
- Nucleus of the cell may be damaged.
- Nucleus may shift in position.
- Size of nucleus may be reduced or may be enlarged.
- Nucleus may be totally destroyed.
- Vacullation is observed inside the cell.



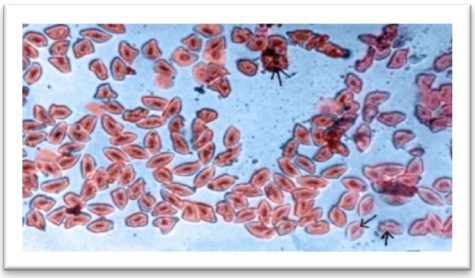
Normal blood smears of fish *Labeo rohita*.



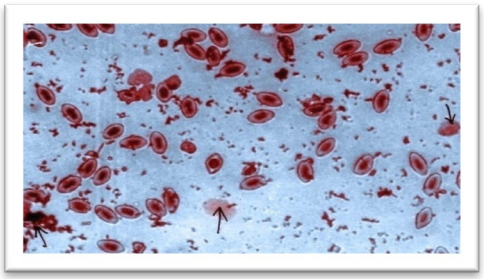
Cell membrane wrinkled and damaged.



Nucleus shift in position.



Size of nucleus reduced or enlarged.

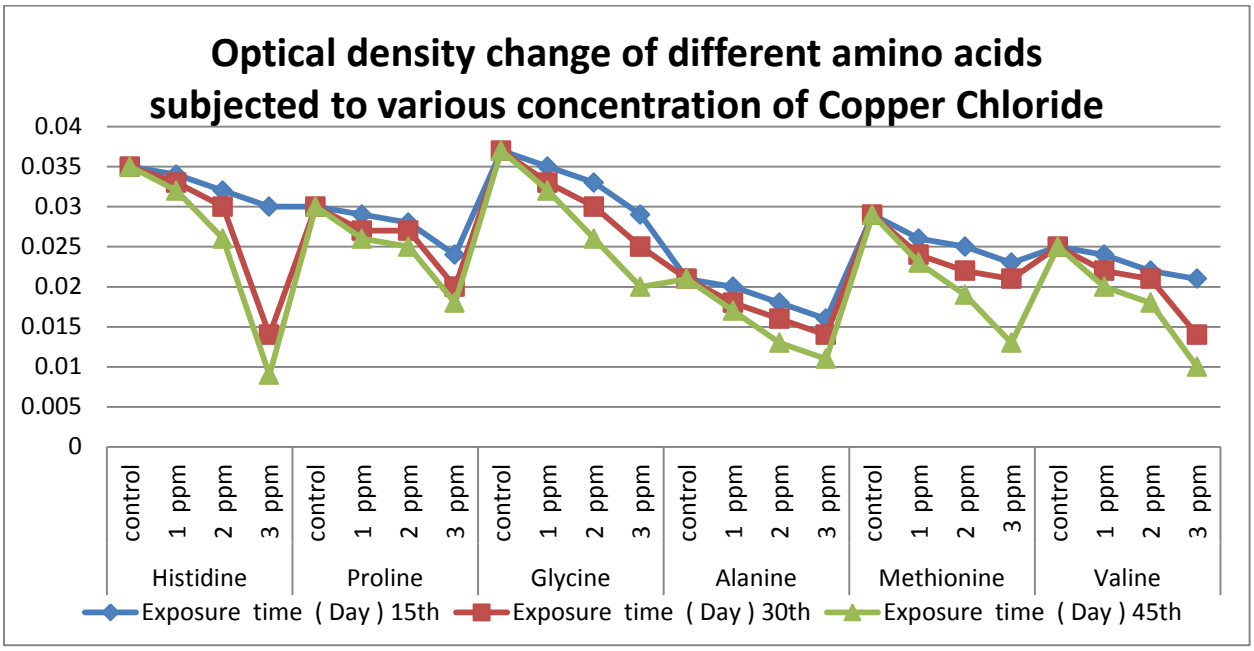


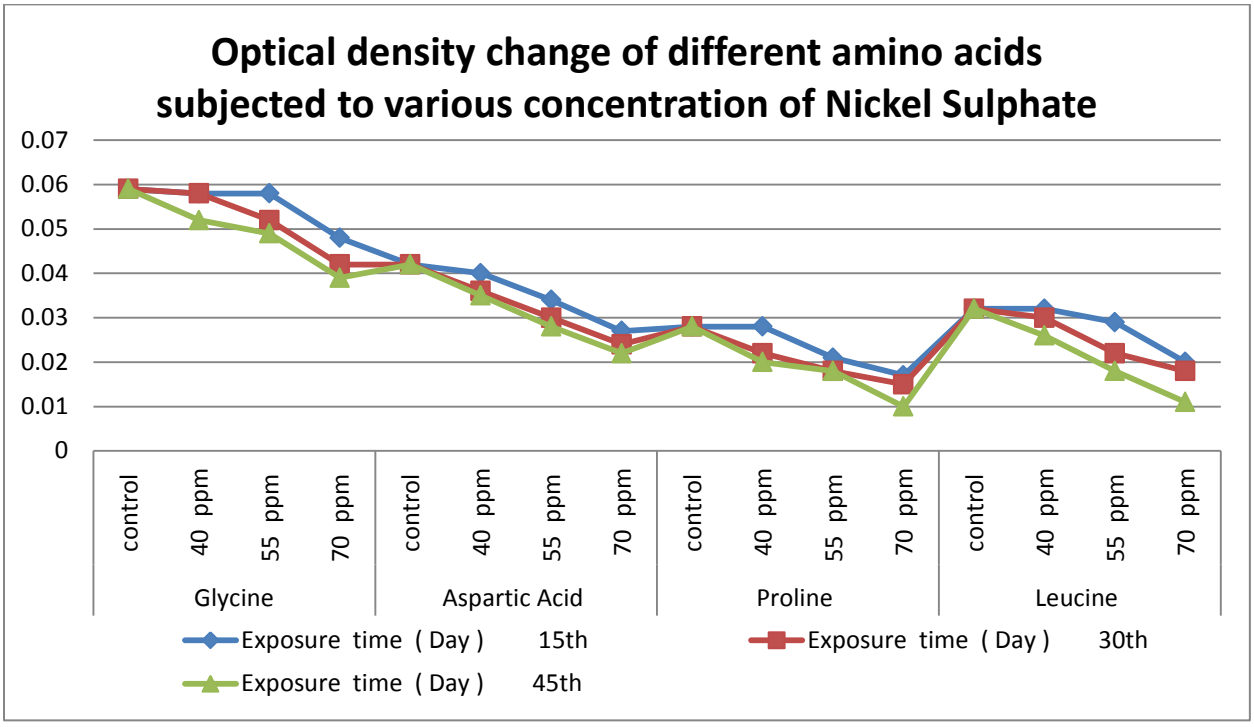
Vacullation is observed inside the cell.

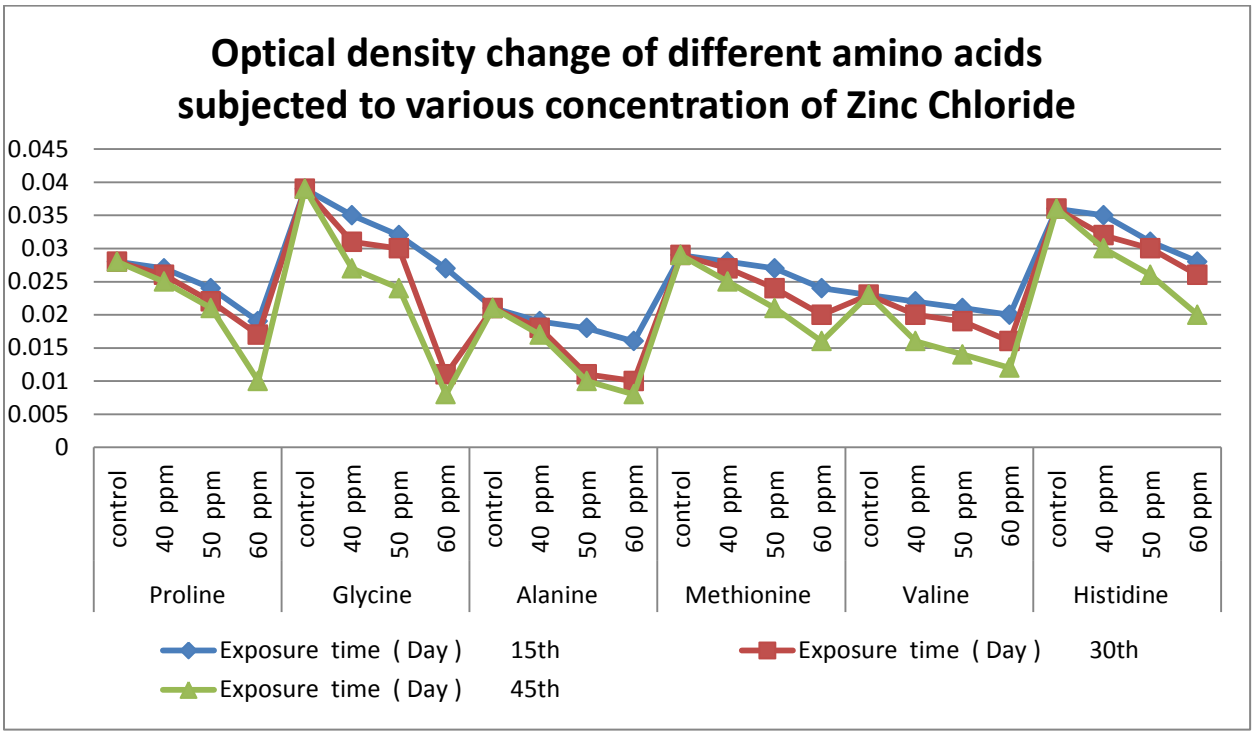
Result of physiological changes due to the effect of heavy metal on fish *Labeo rohita*:

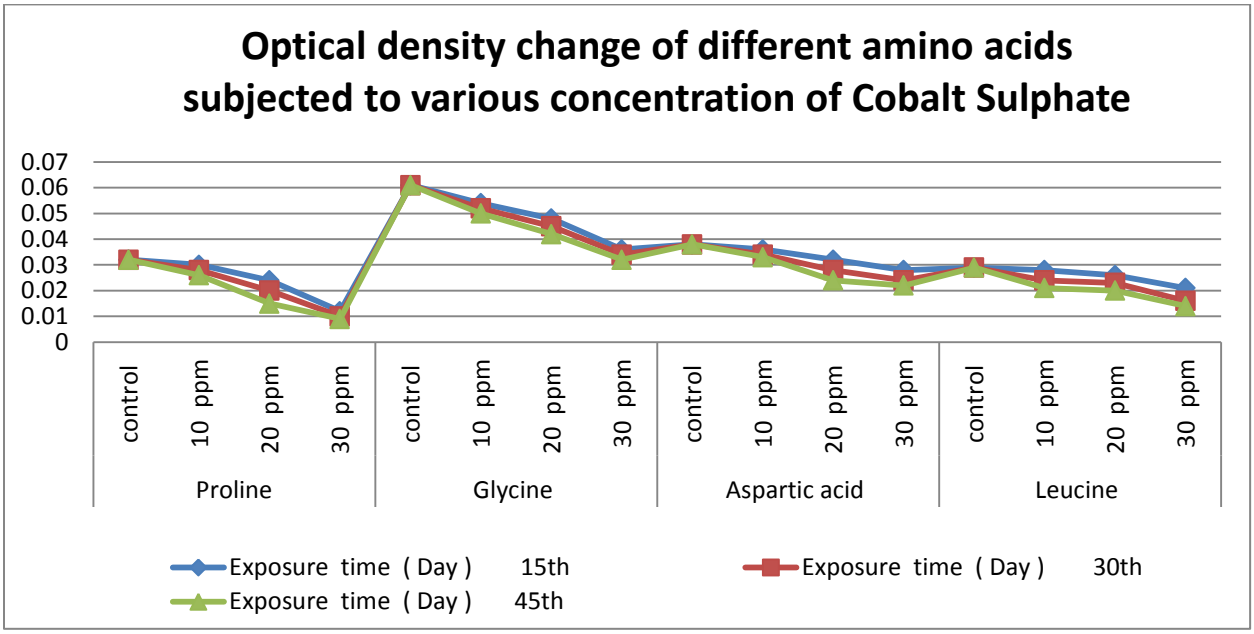
Optical density change of different amino acids subjected to various concentrations in ppm of Heavy metal salts was observed.

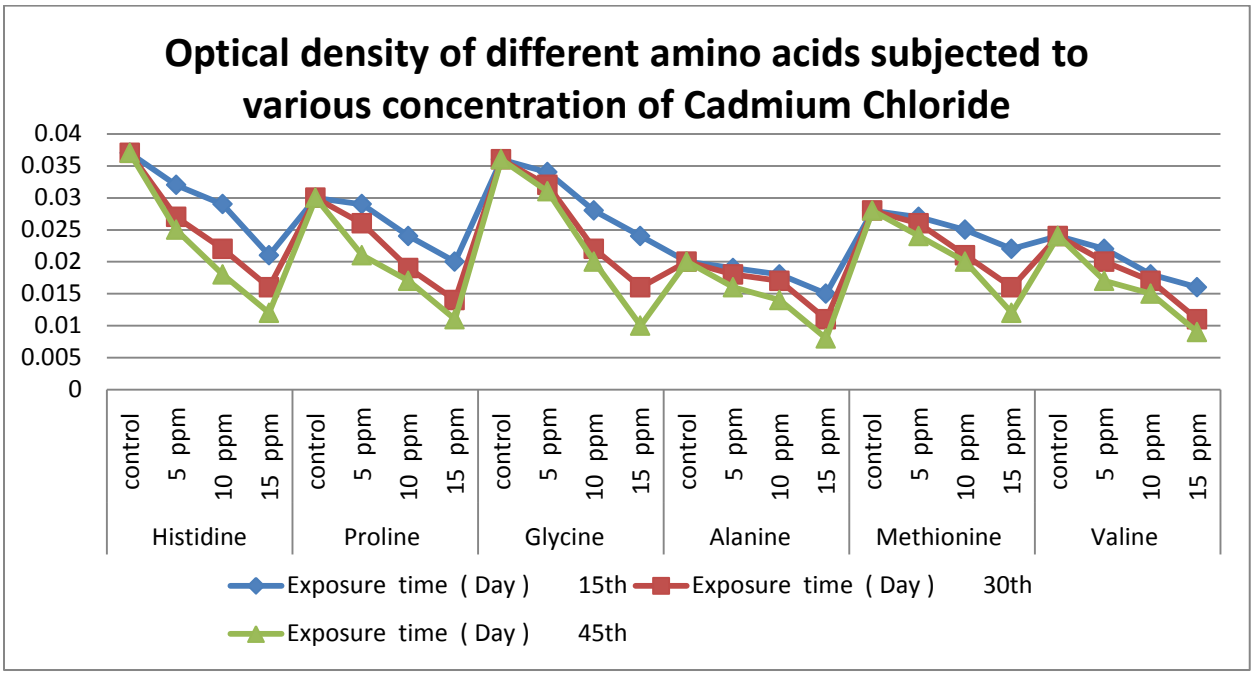
- In case of Chlorides of Copper, Zinc, and Cadmium; amino acids like Valine, Histidine, Proline, Glycine, Alanine and Methionine were seen to be declining.
- In case of Sulphate of Nickle and Cobalt, amino acids like Leucine, Proline, Glycine and Aspartic acid showed a tremendous decrease in amount.
- The results clearly indicate the decrease of protein content in fish and all aquatic animals.


Optical density change of different amino acids subjected to various concentration of Copper Chloride
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
control
1 ppm
2 ppm
3 ppm
Histidine
Proline
Glycine
Alanine
Methionine
Valine
Exposure time (Day) 15th
Exposure time (Day) 30th
Exposure time (Day) 45th


Optical density change of different amino acids subjected to various concentration of Nickel Sulphate
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
control
40 ppm
55 ppm
70 ppm
Glycine
Aspartic Acid
Proline
Leucine
Exposure time (Day) 15th
Exposure time (Day) 30th
Exposure time (Day) 45th


Optical density change of different amino acids subjected to various concentration of Zinc Chloride
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
control
40 ppm
50 ppm
60 ppm
Proline
Glycine
Alanine
Methionine
Valine
Histidine
Exposure time (Day) 15th
Exposure time (Day) 30th
Exposure time (Day) 45th


Optical density change of different amino acids subjected to various concentration of Cobalt Sulphate
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
control
10 ppm
20 ppm
30 ppm
Proline
Glycine
Aspartic acid
Leucine
Exposure time (Day) 15th
Exposure time (Day) 30th
Exposure time (Day) 45th



CONCLUSION:

Conditions like wrinkled cell membrane damaged or enlarged nucleus and vacullation lead either to anemic condition of animals or death in the long run. Anemic conditions and less iron content have been reported in fish, bird and mammal following exposure to pollutants by several researchers. Also, RBCs count declined in fish subjected to higher concentration of endosulfan. It has also been postulated that the reduction of RBCs count might be due to inhibition of RBCs production and destruction of RBCs by pollutants[1]. Protein deficiency in a human body leads to a number of health related problems, including reduction of chondroblastic and osteoblastic activity. This leads to an acute situation where the normal growth and formation of the bones and the cartilage gets hampered, which finally results in irreparable deformities in body of the growing children, and also in adults. Fish is the staple food of the people of coastal region in India. Hence it is a matter of utmost importance to study and constantly monitor the various heavy metal pollutants in water in and around the coastal region over the Globe as Humans consuming the affected fish suffers damage to liver, kidney, heart, body-joints. The liver and kidneys produce metallothioneins causing toxicity which is hazardous to human life. After this study of the effects of heavy metals on the environment and living organisms, mainly human beings, effective legislation, guidelines and detection of the areas where there are higher levels of heavy metals are necessary. Failure to control the exposure will result in severe complications in the future because of the adverse effects caused by heavy metals. Occupational exposure to heavy metals can be decreased by engineering solutions. Monitoring the exposure and probable intervention for reducing additional exposure to heavy metals in the environment and in humans can become a major step towards prevention. National as well as international co-operation is vital for framing appropriate laws to prevent heavy metal toxicity.

REFERENCES:

1. Anusha. (1994). Effect of endosulfan on oxygen consumption, red blood cell count and food utilization of fresh water fish *Clarius dussumieri*, *J. Environ. Toxicol.*, 4(1), 1-63, 33-36.
2. Galat, D.L., G.Post; T.J. Kerfe and G.R.Boucks,(1985). Histopathological changes in the gill, kidney and liver of Lohonta cut throat trout, salmo clarki Henshawi, living in lakes of different salinityalkalinity. *J.Fish. Biol.* 27, 533-552.
3. Hayes, W. J. 1982. *Pesticides studied in man.* Baltimore, MD: Williams and Wilkins.
4. Joshi, H.C., (1990). *Environmental constrains in management of fisheries in open water system. Proceedings of the National Seminar on Management of fisheries in Inland open water system of India, barracpore.* West Bengal India. Dec. 1988. (1990), 23-30.
5. Mosby CV, Glanze WD, Anderson KN. (1996). *Mosby Medical Encyclopedia,* The Signet: Revised Edition. St. Louis.
6. Nicolaidou, A. and J.Nott , (1989). Heavy metal pollution induced by ferronickel smelting plant in Greece. *Sci. of the Total Environ.* 84, 113-117.
7. Nriagu, J.O. and J.M Pacyna.,(1988). Quantitative assessment of worldwide contamination of air, water and soils by trace metals. *Nature* 333: 134-139.
8. Olojo, E.A.A., Olurin, K.B., Mbaka G.and A.D. Oluwemimo, (2005). Histopathology of gill and liver tissue of the african catfish *Clarias gariepinus* exposed to lead. *African J. Biotechnol*. 4(1) 117-122.

9. Toxne T. 1975-1986. National library of medicine's toxicology data network. Hazardous Substances Data Bank (HSDB). Public Health Service. National Institute of Health, U. S. Department of Health and Human Services. Bethesda, MD: NLM.
10. Wilson, B.L., Schwarzer, R.R. and N. Etonyeaku, (1986). The evaluation of heavy metals (Cr, Ni and Co) in the aqueous sediment surrounding a coal burning generating plant. *J. Enviorn. Sci. Health.* 21, 791-808.

Objectives of plans or programmes and environmental protection objectives – A contradiction?

Felix Sternath, RaumUmwelt, Vienna, Austria

Abstract

The European Union SEA Directive (2001/42/EC) addresses objectives in two ways: First, it is necessary to outline the objectives of plans or programmes in the environmental report; reasonable alternatives have to take account of these objectives. Second, the environmental report shall provide information on environmental protection objectives.

Objectives of plans or programmes, on the one hand, and environmental protection objectives, on the other, are sometimes similar or the same thing; in most cases, however, they are not. Mostly they are considered as two different things. This understanding of objectives is one of the main reasons for SEA's limited influence.

Good planning does not distinguish between objectives of plans and programmes, and environmental protection objectives. The success of SEA lies in integrating all types of objectives in a single process. This does not necessarily lead to a trade-off and it makes decision-making more transparent.

The following paper illustrates two exemplary Austrian approaches of how objectives can be regarded in SEA in an integrated way. The first is from an SEA guideline for provincial road corridors in Vorarlberg. The second is from a manual for SEA in town planning in Lower Austria.

Introduction and legal framework

Policy processes are mainly about defining and meeting objectives. No plan, no programme and no policy can ever be adopted without outlining the underlying objectives. The success of a plan, programme or policy is usually assessed by means of target achievement controls. Audit offices usually do not question the content of a policy itself, but they scrutinize the efficiency of a measure in regards to the assumed objectives.

Therefore it is astounding that this crucial aspect of policy making – defining objectives – is underrepresented in the legal foundations of most countries, states or provinces. It is widely undisputed that defining objectives is the sole domain of the political sphere, although the way how objectives are defined greatly influences the content of policies. Questioning this "unwritten rule" is often considered as an undesirable interference with political processes – and this is where SEA comes into play.

SEA addresses the issue of objectives, commencing with the European Union SEA Directive (2001/42/EC). First, it grounds parts of its provisions on the objectives of the plans or programmes that are subjected to SEA. Second, it requires an uncompromising assessment of plans or programmes for environmental objectives, which is more easily said than done.

As a result, the way of dealing with objectives based on the SEA is usually unsatisfactory: The two types of objectives which the SEA Directive refers to are often considered as two different and independent issues. Either objectives arise from the plan or programme themselves or objectives are derived from the outside world and forced into the assessment; the latter is the case with environmental protection objectives as the SEA Directive calls them.

The problem: Separate consideration of objectives of plans or programmes and of environmental protection objectives

European Union SEA Directive (2001/42/EC), which is by now implemented in the Member States' legislation on several territorial and governance levels, is concerned with objectives in two different ways:

First, based on annex I, outlining the objectives of the plan or programme in the environmental report is mandatory, as reasonable alternatives have to take account of these objectives (article 5). So, according to the SEA Directive this first objective basically comprises the motivation of the plan or programme which is usually expected to be of economic or social nature[1]. Whether or not a plan or programme meets these objectives or whether there are other alternatives that meet these objectives more accurately, is not the subject of the assessment.

Second, the environmental report shall provide information on the environmental protection objectives, *"which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation"*. So, according to the SEA Directive, there is a second, generally speaking different type of objective, which concerns "the environment" and forms the basis for the assessment of the plan or programme within an SEA.

The separation of these two types of objectives is to be considered one of the main obstacles for "good" SEA practice. There are basically two reasons for this:

First, the separation of different types of objectives, completely ignores that environmental objectives may often be at the same time objectives for the plan or programme itself. This does not only concern plans or programmes that are prepared, for example, for the management of a protected area or for policies that deal with environmental protection. Plans and programmes in developed countries that are subjected to the EU SEA Directive, usually concern the modification of already well developed systems, i. e. making them often more sustainable.

Second,– and this goes to the heart of the matter – before being subjected to SEA, plans or programmes are usually prepared in course of "the planning process" itself. Only after that, a more or less completed plan or programme will be assessed. This fact is perfectly understandable, especially in developed countries, as planning processes "themselves" are strictly regulated and by law often must encompass many different issues, including environmental concerns.

As a result, plans and programmes only rarely change during SEA and SEA has only very little influence on the content of plans and programmes. SEA rather prevents particularly adverse effects of a plan or programme and therefore often functions very similar to EIA.

Furthermore, there usually is a significant shortcoming in the evaluation of alternatives. This is due to the fact that the "primary" planning process, where a plan or programme is developed on the basis of pre-identified objectives, often does not require an alternatives assessment. Plans and programmes then enter the phase of SEA, when they are already highly elaborated and therefore in a stage, where it is hard to identify "reasonable" alternatives. This is less a problem regarding the assessment of environmental effects; it's rather a shortcoming of transparency and "planning culture" *per se*.

Finally, this leads to a situation where SEA is considered superfluous – both by decision makers who need to spend time and money for SEA, and the general public missing a real chance of influencing a planning process.

[1] Unfortunately, SEA Directive gives only very few indications of what should be considered as an objective. This usually misleads practitioners and decision makers to pay only very little attention to the formulation of objectives and to mix up the content of the plan or programme itself ("the measures") with the objectives that should underlie the policy making process.

Example 1: SEA guidelines for provincial road corridors in Vorarlberg, Austria

Vorarlberg is a comparably small alpine Austrian province (*Land*) located on the country's western boarder to Switzerland. Vorarlberg however, has a rich industrial tradition and is considered a prime example for "good" architecture, town planning and mobility policies. In 2012, Vorarlberg introduced SEA in the sector of road planning, both for provincial and municipal road networks.

According to the Vorarlberg's Roads Act, the provincial government needs to determine a road corridor before decreeing a provincial road. This road corridor is considered a plan according to the SEA Directive. The need for a road corridor was implemented contemporarily with the implementation of SEA for this type of plan. This situation caused the rare chance to implement SEA together with a totally new planning process; usually, SEA is implemented only after the corresponding plan or programme and especially planning processes have already been applicable for years.

Therefore, the developed SEA guidelines (Administration of the State of Vorarlberg, 2014) encompass the entire planning process which, according to the SEA Directive, in certain cases does not require an SEA. The government department responsible for provincial road planning uses the guidelines as sole basis for the entire planning process. In fact, the first steps provided by the guidelines do not distinguish between planning processes with or without SEA. The decision whether or not to undertake an SEA is to be taken during the planning process.

Some of the key specifications of the SEA guidelines relate to the question of objectives. The so-called planning order by the responsible member of the provincial government is the first step towards the planning of a provincial road. The planning order is indispensable for triggering the activities by the department responsible for provincial road planning and needs to include clear information on the objectives. These objectives often include environmental objectives, as improving the road network in Vorarlberg is very often linked to the aim of a more sustainable and safer mobility system. As soon as the planning department receives the planning order, it is required to further develop the planning order and include – most of all – a planning area.

The screening is carried out exclusively based on the following question: Given the objectives and the planning area defined in the planning order, can significant effects on the planning area be expected? Therefore the decision on whether or not to conduct an SEA is taken before even the first draft of a road corridor resp. corridor alternatives is designed.

As a further result, the identification and evaluation of alternatives is at the heart of the planning and – in case of the need for an SEA – also the SEA process. Alternatives, which usually include an array of 3 to 5 road corridor options that are all equally designed and described, are assessed both in terms of functional, technical respectively economic and environmental effects or characteristics. The recommendation for a certain corridor alternative is therefore based on several aspects with environmental concerns always being a part of the decision criteria.

The full integration of SEA and the planning process also implies the complete integration of environmental report and "technical" report. In order to avoid a "trade-off" of functional and economic aspects, on the one hand, and those traditionally "environmental", on the other, the SEA guideline includes clear requirements on which environmental aspects to deal with and how to deal with them.

The experiences at hand from using the SEA guidelines show three positive aspects: First, environmental issues are totally accepted and included right from the beginning of the planning process. Second, participation requirements that derive from SEA are successfully carried out for the entire planning process. Third, as all relevant aspects for decision making are documented in a single report and are subject to participation, decision making is very transparent and traceable.

Example 2: SEA manual for town planning in Lower Austria, Austria

Lower Austria is Austria's largest province (*Land*) by area. It surrounds Austria's capital, Vienna, which is a *Land* itself. Therefore, Lower Austria is basically characterised by two very different spatial patterns: Central Lower Austria is part of the densely populated Vienna region; the peripheral is mostly sparsely populated with decentralised, comparably small settlements. In 2014, Lower Austria decided to revise its SEA manual, starting with the methodological part (Administration of the State of Lower Austria, unpublished).

According to Lower Austria's Regional and Local Planning Act, development plans and zoning plans on municipal level need to be subjected to SEA whenever they are changed or entirely revised; few exceptions apply for minor changes. SEA by now is already broadly established and manuals for different steps of SEA or SEA preparation (e. g. screening) are generally successfully applied. However, the quality of SEA, both regarding content and process, is partly rather uneven. Therefore the provincial government decided to set up a comprehensive manual for SEA methodology.

The underlying idea of the manual is – again – to provide the best possible integration of the planning process "itself" and the SEA process. This is to avoid that decisions are basically taken before the start of an SEA. The manual contains two basic specifications: First, the environmental report is completely integrated in the "technical" report (respectively vice versa). Second, the applicable methodology does not operationally distinguish between objectives for the plan or programme and environmental objectives.

The methodology actually largely neglects the necessity of autonomously defining the objectives, as the basic objectives for municipal planning that can be found at the heart of every planning intention on municipal level, are essentially defined by provincial law or provincial strategies, plans or programmes. However, as circumstances vary between municipalities, it is important to weight the different thematic aspects during the scoping process. By doing so, some aspects can be even excluded from the assessment right from the beginning.

On the operational level, the manual is designed to be all-encompassing. It basically contains an extensive hierarchic matrix that covers all thematic aspects that can possibly be relevant for decision making – including the environmental ones. It breaks down every thematic field: from 3 main focuses to 6 fields of action to 12 thematic areas to 34 sub-aspects. For every sub-aspect, the matrix contains specifications for describing the current state of environment, typological influences and effects. For the assessment itself, methods are prescribed on three different depths for every sub-aspect. The decision which depth is going to be applied is taken during the scoping process.

This concept of a manual is of course quite restrictive and limits the room for manoeuvre for the users. However, to prepare a manual of this sort was a deliberate decision with a strong motivation: As the quality of SEA is partly rather moderate, the competent supervisory authorities on provincial level considered a stronger guidance as would be necessary. With the new manual at hand, it should be easier to jointly specify the scope of assessment including the methodology. This is considered to be especially supportive for the many small municipalities which often do not have the personnel and / or economic resources to effectively deal with demanding SEA cases.

The manual is currently subject to a final coordination process with the relevant experts of the provincial government. However, it was already tested by consultants who were not involved in the design of the manual. First experiences show that the all-encompassing nature of the manual is considered rather challenging at the start, but after getting used to it, users tend to appreciate the clear and dependable working process.

Concerning content-related aspects, it is still too early to evaluate whether the new manual helps to improve the quality of SEA. However, the experts involved see a good chance that decision processes will be more transparent and including and will be therefore more open.

Conclusions and proposal for a revision of the SEA Directive

The title of this paper includes the question whether objectives of plans or programmes and environmental protection objectives constitute a contradiction within SEA. Of course they do not – this is not the main finding of this paper. But the two examples provided in the paper strengthen the argument that these two types of objectives which are addressed by the SEA Directive need to be considered in an integrated way in order to apply SEA as a part of "good" planning processes.

The more developed our countries and the more established our planning culture, the more "technical" and environmental protection objectives resemble one another. Planning without considering environmental aspects at all is almost impossible nowadays – it did not need the SEA for that. Reciprocally, SEAs detached from the planning process as strict tools to enforce environmental concerns may have been the secret wish of environmental extremists, but it turned out that such SEAs simply do not work.

SEA is successful if we manage to integrate as many environmental concerns into the core of the planning process without insisting on exceptional attention to be paid to them. Referring to the SEA Directive currently in force, the following practices turned out to be useful to achieve this goal:

Fully integrate the "traditional" planning process and the SEA process. This can be best achieved by not distinguishing between objectives of plans or programmes and environmental protection objectives. Sometimes they are the same, often they do not contradict each other and never there is a reason why one type of objective should be considered only after another type of objective has already been considered.

Practitioners who have decades of experience with "traditional" planning processes often have difficulties with SEA. As soon as the "technical" report on a plan or programme is completed they do not see the need for further discussions. In that case it is helpful to fully integrate the "technical" report and the environmental report. This report shall contain all arguments that are relevant for decision making, independently from the source (objective) they refer to.

This also benefits the alternatives assessment considerably. The rationale of identifying and evaluating alternatives is carried to the core of plan making. Documenting this process in a common report is a huge leap in transparency.

This does not question or limit the primacy of politics at all. It rather strengthens it by further developing planning in the context of the shift from government to governance. Civil society requires being part of all stages of plan-making. This certainly includes the definition of objectives. And we can be sure of one thing: An alert and empowered civil society is the best guarantee for environmental issues to be addressed satisfactorily.

Regarding the future revision of the SEA Directive, embedding this approach in the SEA Directive would certainly be desirable. The SEA Directive currently in force scarcely addresses the question of objectives of plans and programmes and the integration of planning process and SEA process. This is to be considered as a shortcoming that produces tame SEA processes – this is a real threat to SEA: Poor results and limited influence of SEA continue to be the best argument to completely abolish the instrument as such.

So it is the responsibility of the European Commission to clearly define what SEA should be and what SEA should consist of. It is simply not enough to rely on the member states' goodwill in implementing the SEA Directive.

References

Administration of the State of Lower Austria (Amt der Niederösterreichischen Landesregierung, unpublished): Leitfaden SUP. Modul 1: Methoden. St. Pölten / Vienna.

Administration of the State of Vorarlberg (Amt der Vorarlberger Landesregierung, 2016): Strategische Umweltprüfung (SUP) für Straßen- und Wegekonzepte. Leitfaden. Bregenz / Vienna.

Administration of the State of Vorarlberg (Amt der Vorarlberger Landesregierung, 2014): Strategische Umweltprüfung (SUP) für Landesstraßenkorridore. Leitfaden. Bregenz / Vienna.

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment

Regional and Local Planning Act of the State of Lower Austria (NÖ Raumordnungsgesetz 2014, LGBl. Nr. 3/2015 idF LGBl. Nr. 63/2016)

Roads Act of the State of Vorarlberg (Gesetz über den Bau und die Erhaltung öffentlicher Straßen sowie über die Wegefreiheit, LGBl. Nr. 79/2012 idF LGBl. Nr. 54/2015)

Overview of EIA systems in oil producing countries of Africa

1. Introduction

Within the last decade, African countries have discovered new oil deposits in commercial quantities (Aryeetey and Asmah 2011). The increase in countries with oil deposits has enhanced the importance of having effective Environmental Impact Assessment (EIA) systems and practice within the continent. Many arguments have been presented as to why oil producing countries in Africa require national EIA systems, amongst which include: to internally control the management of the environment, to issue fines and raise revenue from proponents to aide response to spill incidents, to regulate the technologies used on the environment, to improve local engagement between the regulator, proponent and the host communities and ensure corporate social responsibility programs are done by the proponents. In most African countries, pressure from international donors and in some cases; environmental disasters faced by the countries also accelerated the setting up of EIA systems (Kakonge 2006). This paper aims to evaluate and establish the legal framework for EIA systems in nineteen oil producing countries (See Figure 1) in Africa and propose recommendations for improvements. In doing so, the first section introduces the topic and the purpose of the research. The second section outlines the methodology while the third section summarizes the findings. Finally, conclusions are provided.

Figure 1. Map of oil producing countries in Africa (source: author)

2. Methodology

The rationale for selecting the 20 countries was based on their location in Africa and their level of crude oil production (Minimum of 1000 barrels per day) (EIA 2014). The evaluation framework developed in this paper is adapted from Ahmad and Wood (2002). A total of 19 criterion were used which are grouped under three major headings- a) EIA legislation; b) EIA administration; c) EIA process (See Table 1).

Table 1. EIA evaluation criteria: systematic measures

(Source: adapted from Ahmad and Wood (2002)

Criteria
EIA legislation
1. Provisions for Environmental Impact Assessment
2. Year of enactment
3. Status of EIA regulation
4. Legal provision for appeal
5. Time limit
6. Strategic Environmental Assessment provision
EIA administration
7. Environmental Impact Assessment regulatory body
8. Review committee
9. Sectorial authority role
EIA practice
10. Screening
11. Scoping
12. Alternatives
13. EIA specified report content
14. Public participation in Environmental Impact Assessment
15. Environmental Management Plan required
16. Requirement for impact mitigation
17. Experience in Strategic Environmental Assessment
18. Sectorial authority regulation
19. EIA implementation monitoring

In evaluating the African countries against the criterion developed above, a systematic literature review was carried out. Similar to an approach adopted by Jha-Thakur and Fischer (2016), this work reviews five leading journals on EIA including- a) Environmental Impact Assessment Review (EIA Review); b) Journal of Environmental Assessment Policy and Management (JEAPM); c) Impact Assessment and Project Appraisal Journal (IAPA); d) Journal of Environmental Planning Management (JEPM) and e) Journal of Environmental Management. This was further complemented by a wider literature review, documentary analysis (especially for French/Portuguese speaking countries) and input from EIA experts. Input from relevant environment ministry of the respective countries was sought. The review aimed to identify the developed criterion's in the EIA systems of each country. A matrix was constructed identifying the different countries and the criterion's they meet. The summary of the findings is presented in Table 2.

3. Results and findings

Table 2 below shows the results of the review. Of the countries discussed in this paper, Algeria was the first to issue EIA legislation through the Law 83-03 of 1983 on the protection of the environment (CITET 2003). Followed by Congo (Brazzaville) in (1986) and Tunisia in (1988).

Table 2. summary of the results of EIA legislation, administration and practice.

Criteria	Summary
EIA legislation	
1. Provisions for Environmental Impact Assessment	In 18 countries
2. Year of enactment	1983 to 2011
3. Status of EIA regulation	18 countries enacted and 2 drafted
4. Legal provision for appeal	In 6 countries, not available in 9 countries and no information on 5 countries
5. Time limit	In 5 countries with respect to submitting final report, specified time limits for components in 7 countries and no provision on 8 countries
6. Strategic Environmental Assessment provision	SEA provision in 3 countries, and no provision on 17 countries
EIA administration	
7. Environmental Impact Assessment regulatory body	Multiple regulatory bodies in 7 countries, Single regulatory body in 11 countries and no information on 2 countries
8. Review committee	In 15 countries, no provision in 1 country and no information on 4 countries
9. Sectorial authority role	In 11 countries, no provision in 4 countries and no information on 5 countries
EIA practice	
10. Screening	In 16 countries, no provision in 1 country and no information on 3 countries
11. Scoping	By proponent in 11 countries, by regulator in 4 countries and not specific on 5
12. Alternatives	Provision in 7 countries, no provision in 10 countries and no information on 3
13. EIA specified report content	Content specified in 16 countries, no specification in 2 countries and no information on 2
14. Public participation in Environmental Impact Assessment	Provision in 13 countries, no provision in 5 and no information on 2
15. Environmental Management Plan required	Provision in 12 countries, no provision in 6 countries and no information on 2
16. Requirement for impact mitigation	In 18 countries, no information in 2

17. Experience in Strategic Environmental Assessment	In 2 countries, no provision in 14 and no information on 4
18. Sectorial authority regulation	In 10 countries, no provision in 7 countries and no information on 3 countries
19. EIA implementation monitoring	Legislated in 13 countries, no provision in 5 countries and no information on 2

EIA legislation

Majority of the EIA legislation were put in place from 1983 to 2000. Since then, there have been advancements within the scope of EIA and its aim to help achieve sustainable development. Most of the countries require review of the current EIA laws to bring it up to date with current practices such as the inclusion of Strategic Environmental Assessment. (SEA). An appeal process is important especially as it provides an outlet for the aggrieved party to seek justice in a civilized manner. Most countries do not currently have legal provisions to appeal within their EIA legislation; this is left up to the courts which tend to be slow and delays the project. To setup a comprehensive legal provision to appeal, it's important to include an appeal procedure for all stakeholders (proponent, regulator and public) involved in the process. Also, considerations should be given in setting a time limit within which an appeal process should be concluded this is to ensure projects are not unnecessarily delayed by court processes. Currently, SEA is in existence in sixty countries globally (Fundingsland Tetlow and Hanusch 2012) but only in three among the oil producing countries in Africa selected have SEA provision. SEA provisions are extremely lacking within the EIA legislations in oil producing countries in Africa, although other non-legislated mechanisms for conducting SEA might be in place in some contexts; inclusion of SEA legislation will aide environmental management.

EIA administration

Countries with multiple regulatory bodies need to ensure the EIA process is streamlined to reduce cost and bureaucracy. A common trend within countries with review committees is a non-technical person heading such a committee. It is important to ensure committees have technical capacities to make decisions on EIA applications. Sectoral authorities having a role are common in the countries reviewed. It is important to ensure there is no conflict of interest during the EIA process. In the context of Nigeria, EIA in the Oil sector is administered by both the Federal Ministry of Environment (FMENV) and the Department of Petroleum Resources (DPR). This ensures a higher level of regulatory presence but do not translate to a better level of compliance by proponents or regulatory enforcement by regulators. While in the context of Ghana a single administrative body the Environmental Protection Agency (EPA) handles the application and regulation of EIA.

EIA process

The scoping component of the EIA practice in most of the countries reviewed needs to be strengthened to ensure better capture of prospective impacts; this can be achieved by building the capacity of the EIA administrative staff in setting the terms of reference for the proponent or in verifying the scoping report submitted by the proponent. Public stakeholders with vested interest should also be provided an opportunity to participate at the scoping stage of the project, as their local knowledge of the study area cannot be overemphasized. Lessons can

be learned from the South African system; it is successful in finding realistic means to mitigate negative impacts and better technology to evaluate impacts on environment (Duthie 2001). Environmental Management Plan (EMP) and the implementation of monitoring are essential components within practice for an approved EIA to be a success. These components ensure the purpose of an EIA is not defeated. Setting a management plan with targets is of utmost necessity to ensure implementation and monitoring of mitigation measures contained in an EIA. The monitoring of projects also needs to be more thorough and frequent and monitoring reports needs to be made available to the public.

4. Conclusion

The data analysed suggests that the EIA approach of most African oil producing countries is still at the foundation stage of managing negative environmental impacts. The decision-making process is still opaque and limits EIA's ability to encourage sustainable development. Sustainable development can be enhanced, by opening the EIA process to public scrutiny and engaging more with community member of communities where projects are being situated.

5. References

Ahmad, B and Wood, C (2002), 'A comparative evaluation of the EIA systems in Egypt, Turkey and Tunisia', *Environmental Impact Assessment Review,* 22 (3), 213-34.

Aryeetey, E and Asmah, E (2011), *Africa's New Oil Economies: Managing Expectations* (Washington, DC.: Brookings Institution).

CITET (2003), 'Working together to strengthen the environment', *strengthening EIA systems in the Mediterranean region*.

Colón, M. C and Gerena, E. T (2014), 'Oil and gas regulation in Equatorial Guinea: overview', in Practical Law (ed.), *MULTI-JURISDICTIONAL GUIDE 2014 ENERGY AND NATURAL RESOURCES* (Thomson Reuters).

Congo, Republic of the (2009), 'Décret N86/775 du 7/06/86 Rendant obligatoires les Etudes d'Impact
sur l'Environnement ', in MINlSTERE DU DEVELOPPEMENT DURABLE. DE L'ECONOMIE FORESTIERE and ET DE L'ENVIRONNEMENT. (eds.).

Dieudonne, A. (2007), 'The oil industry along the Atlantic coast of Cameroon: Assessing impacts and possible solutions', *Resources Policy,* 32 (3), 135-45.

DRC 'Environmental and Social Management Framework', <http://documents.worldbank.org/curated/en/889041467996698593/text/E4838-V1-EA-P124072-Box396263B-PUBLIC-Disclosed-5-27-2016.txt>, accessed.

Duthie, A. G. (2001), 'A review of provincial environmental impact assessment administrative capacity in South Africa', *Impact Assessment and Project Appraisal,* 19 (3), 215-22.

EIA 'Total petroleum and other liquids production', <http://www.eia.gov/beta/international/data/browser/index.cfm -/?pa=0000000000000000000000000000000000vg&c=ruvvvvvfvtvvvv1vvvvvvfvvvvvvfvvvsu20evvvvvvvvvvvfuvg&ct=0&tl_id=5-A&vs=INTL.53-1-AFG-TBPD.A&ord=SA&vo=0&v=C&start=1980&end=2014&vid=1>, accessed 13th February 2017.

El-Zayat, H., Ibraheem, G., and Kandil, S. (2006), 'The response of industry to environmental regulations in Alexandria, Egypt', *Journal of Environmental Management,* 79 (2), 207-14.

Fundingsland Tetlow, Monica and Hanusch, Marie (2012), 'Strategic environmental assessment: the state of the art', *Impact Assessment and Project Appraisal,* 30 (1), 15-24.

Guinea, Republic of Equatorial (2006a), 'HYDROCARBONS LAW OF THE REPUBLIC OF EQUATORIAL GUINEA', in presidency (ed.), (8; Equitorial Guinea).

--- (2006b), 'MINING LAW FOR THE REPUBLIC OF EQUATORIAL GUINEA Law 9/2006', in presidency (ed.), (9; Equitorial Guinea).

--- (2006c), 'PETROLEUM REGULATIONS OF THE REPUBLIC OF EQUATORIAL GUINEA', *presidency,* Equitorial Guinea.

Jha-Thakur, U. and Fischer, Thomas B. (2016), '25 years of the UK EIA System: Strengths, weaknesses, opportunities and threats', *Environmental Impact Assessment Review,* 61, 19-26.

Kakonge, J. O. (2006), 'Environmental Planning in Sub-Saharan Africa: Environmental Impact Assessment at the Crossroads', *Working Paper* 9.

Mbile, P., et al. (2005), 'Linking management and livelihood in environmental conservation: case of the Korup National Park Cameroon', *Journal of Environmental Management,* 76 (1), 1-13.

Morgan, Richard K. (2012), 'Environmental impact assessment: the state of the art', *Impact Assessment and Project Appraisal,* 30 (1), 5-14.

Zhang, Jie, Kørnøv, Lone, and Christensen, Per (2013), 'Critical factors for EIA implementation: Literature review and research options', *Journal of Environmental Management,* 114, 148-57.

Efficiency of ESIA Compliance and Follow-up in Cameroonian Extractives Industries

By: Juliet TAZA-ASABA

1. INTRODUCTION

Endowed with many different landscapes rich in diverse socio-economic and socio-cultural attributes, Cameroon is often termed 'a *Geological Catastrophe'*. Despite this potential, Cameroon has not taken advantage of the boom in mineral trade, which stood at a global level of over 820 billion Euros in 2006 (National Institute of Statistics as cited in www.eia.doe.gov). According to the NIS (2006), the country's Gross Domestic Product (GDP) for the extractive industries represented 966 billion Euros, 955 billion for the oil sector and 11 billion for the mineral sector.

Today, focus is on the mining sector which is believed to offer a huge potential for augmenting the contribution of the extractive industries to the country's revenue, evident by the hundreds of mining permits issued by government to national and foreign mining companies.

The majority of mining permits are in areas of primary biodiversity importance (Figure 1). The challenge for the government is in the choice of the best approach in reconciling its economic and environmental objectives. The government in 1996 adopted the Environmental Management Framework Law, which demands the realization of Environmental and Social Impact Assessment (ESIA). In 2013, legislative amendments required compliance and follow-up of projects subject to ESIA (as defined by article 27 of decree no 2013/0171/PM of 14th February 2013 on the modalities for carrying out ESIAs).

ESIA and consequent follow-up thus remain the key tools to reduce and/or address and compensate (Figure 2) for negative impacts of development operations and enhance associated positive impacts. Section 19(2) of the 1996 environmental management framework law in Cameroon provides for environmental compensation. The growing presence of mining projects in zones of primary ecological importance (Fig. 1) has made some companies consider options to better compensate for their impacts. In this context, WWF CCPO commissioned a study with a focus on examining the state of environmental compensation in Cameroon with the overall objective to evaluate the current level of implementation of compensation as a measure to offset impacts in Cameroon.

1.1.Methodology

The methodology used involved literature review and primary data (field visits, interviews and direct field observations) collection and interpretation. Literature review focused on environmental compensation policy frameworks, evaluation of Environmental and Social Management Plans (ESMP) against UNEP's criteria and evaluation of ESIA Follow-up Reports and stakeholder engagement reports.

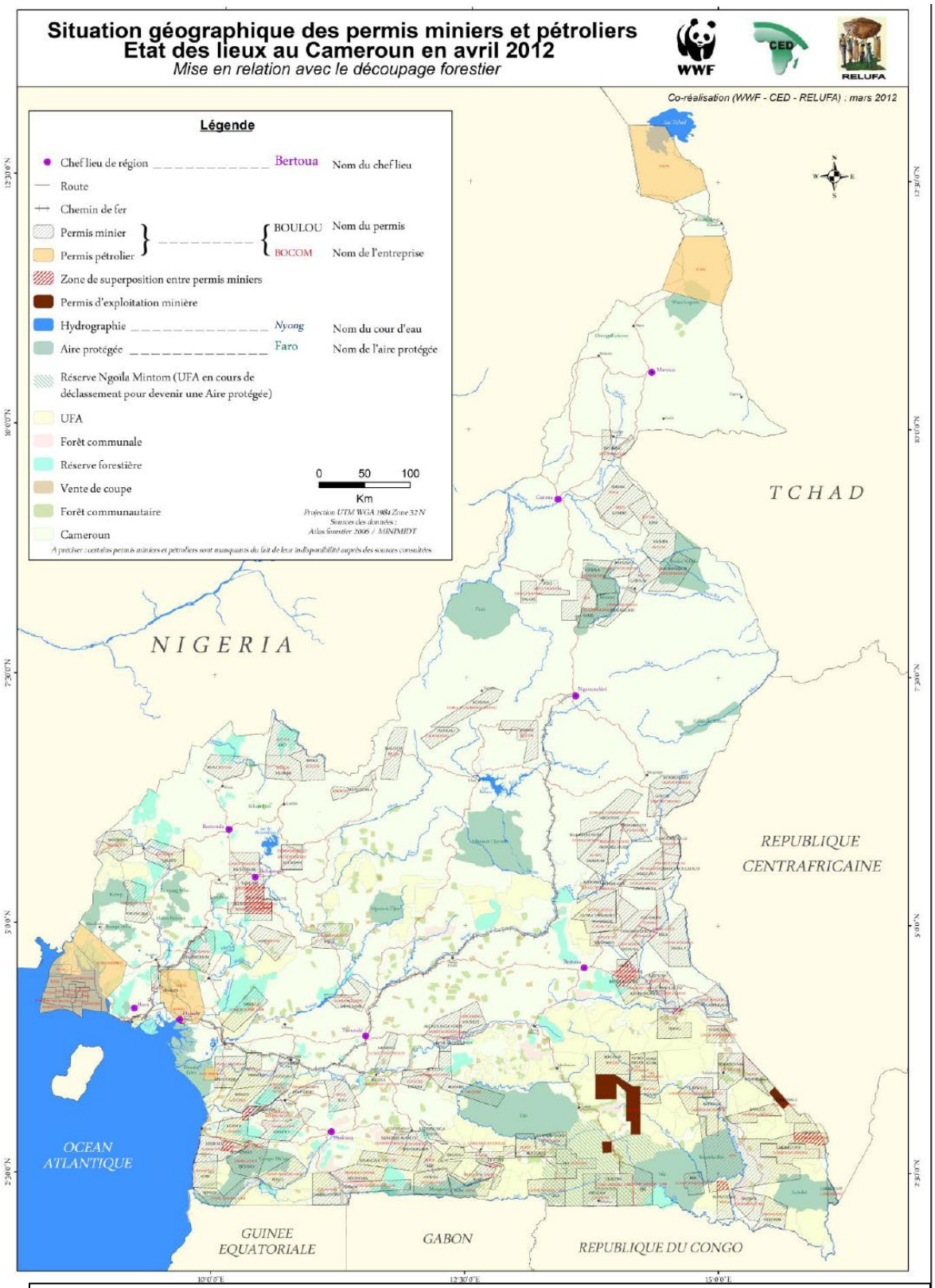


Figure 1 : Map of Cameroon

Field visits provided *on the ground* information on the situation of ESIA Compliance and follow-up from all stakeholders involved in the process. Projects examined within this context included: CamIron

Mbalam Iron ore exploration, Geovic cobalt and nickel exploitation, CAMINEX Nkout iron ore exploration and C&K diamond exploitation. Additionally, discussions were carried out with some oil exploration and oil transportation companies in Douala like Kosmos Energy Cameroon, DANA Petroleum and COTCO. Prior to report submission, key findings were presented to stakeholders during a workshop on legal and best environmental and social practices in the extractive sector in Cameroon.

1.1.1. Origin of Environmental Compensation

Environmental Compensation originates from the mitigation hierarchy as follows:

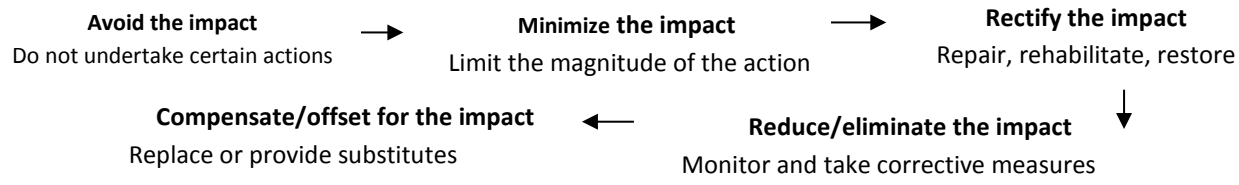


Figure 2: Mitigation hierarchy Source: Adopted from Price water house Coopers LLb, 2010)

CHAPTER 2. Legal Frameworks and Initiatives on Environmental Compensation

2.1. International Legal Provisions for Environmental Compensation

Internationally agreed upon environmental goals ensuing from legally and non-legally binding instruments, principles and guidelines on sustainable development advocate for compensation for adverse effects. Consequently, environmental compensation is included as part of the ESIA process and therefore provided for by law. The Convention on Biodiversity (CBD) an international agreement signed in 1992, inspired the drafting of voluntary guidelines in individual countries on biodiversity-inclusive impact assessment which recommends an analysis of likely success of mitigation measures to include the 'realistic potential to offset adverse project impacts'.

The Business and Biodiversity Offsets Programme (BBOP) instituted in 2002, is a partnership between companies, governments, private/public institutions and financial institutions, aimed at exploring, discussing and advocating for the concept of ecological compensation.

2.2. Cameroon's General Legal Framework on Environmental Management Pertaining to the Extractive Industry

Law n°96/12 of 5thof August 1996 is founded on principles reflecting compensation for environmental damage, an example is in the case of surface and/or ground water pollution or other forms of pollution in general. Chapter 4 of this law requires operations to be carried out as stipulated by international conventions duly ratified by Cameroon with a focus on the Rio Convention on Biodiversity (CIME Services & CSIR, 2013). According to excerpts of this law, Compensation measures (Article 19 section 2) should be provided following impact avoidance and reduction. Consideration of losses to ecological values is given little consideration. The only forms of ecological compensation prescribed by the decree (No. 466/PM of 20 January 1995) of implementation of the forest law pertains to clearing or damage to permanent forest estates, subject to declassification and reclassification of an equivalent area.

Furthermore, compensation for damage to the physical environment and property during project implementation is dealt with by other national legislations. Such compensation applies to expropriation of land and the declaration as public utility.

An administrative framework governs the application of ESIA in Cameroon and ensures appropriate application of environmental compensation measures. Key administrative bodies in this regard include.

- The Inter-Ministerial Commission under the tutelage of the Ministry of Environment, Protection of Nature and Sustainable Development (MINEPDED);
- Ministry of Mines, Industry and Technological Development (MINMIDT); and
- National Hydrocarbons Corporation (*Société Nationale des Hydrocarbures*).

3. EVALUATION OF THE CURRENT ESIA PRACTICE IN CAMEROON

3.1. Evaluation of Extractives Sector ESIA/ESMP

Five (5) out of fourteen (14) ESIA reports, were reviewed against the UNEP criteria for ESIA evaluation. Although there are no specifications on Environmental Compensation, the criterion respects the Environmental Mitigation hierarchy.

Overall, above 80 % of the reports omitted pertinent information, for example: the potential volume of waste to be generated, record of potential emissions to air (including Green House Gasses), job creation opportunities, and proof of stakeholders participation. Such omissions constitute omission in the consideration of Environmental compensation in the ESMP.

40 % of the projects considered for review did not contain a separate comprehensive ESMP which is indispensable but rather provided specific management plans or sub-plans for various aspects, which are usually developed as an outcome of the ESMP to support its implementation. Such action plans are important but should be complimentary to the ESMP. Details on the implementation of mitigation (Environmental Compensation inclusive) measures, the personnel in charge, the cost of implementation and follow-up measures are very important aspects that are usually lost by merely elaborating sub-plans.

3.2. General Analysis of ESIA Reports in Cameroon

The analyses of ESIA and follow-up reports in Cameroon are based on criteria drawn from both Cameroon and UNEP, 2002 for EIA evaluation. In Cameroon, the ESIA process is regulated and a manual has been produced by the MINEPDED for use during the conduct of the studies. From discussions with administrative personnel concerned with the evaluation of ESIA reports, there has been a great improvement in the quality of reports in the recent years. In the quest for improvement of the quality of reports the ESIA decree of 2005 was amended in 2013. Additionally, there exist other legal acts, orders and guidelines to support the ESIA process. All these legislations are harmonized with the UNEP criteria for quality evaluation. However, it is worth mentioning that there exist no regulatory guidelines in Cameroon for Environmental Compensation, and consequently most of the reviewed ESIA reports sparingly address the concept of Environmental Compensation.

In more than 80% of ESIA reports reviewed, Environmental Compensation is not properly addressed. Majority of the reports contain few measures whereas, a limited number of reports pay attention to details and contain specific Environmental compensation plans (for example ESIA for CAMIRON, COTCO, etc.) currently being implemented. The ESIA and follow-up reports of CAMIRON and COTCO were noted to include environmental compensation measures driven by the scope of both projects and requirements of financial institutions. Environmental Compensation is therefore not given its due place

due to its absence in the National ESIA evaluation criteria and limited regulatory framework and guidelines for its application.

3.3. Evaluation of the Level of ESMP Follow-up

According to Nguene *et al.,* 2012, successful implementation of mitigation measures requires that policies and institutions be strengthened to facilitate adequate follow-up. According to Global Village, the Lom-Pangar Hydroelectricity Dam Construction project in Cameroon was criticized for the absence of operational mechanisms for follow-up and the lack of precision on the contents of a follow-up report. Equally, the absence of the local population and the civil society input during follow-up was highlighted. The ECOVOX CIPCRE newspaper in the late 2000s reported non-compliances and the lack of transparency in the monitoring of the Chad/Cameroon Pipeline Project. According to their investigations, the reports of contractors indicated a good monitoring of the social impacts and mitigation/optimization measures on the ground, while NGO reports indicated many cases of non-compliance particularly with regards to compensation. Rainbow Environment Consult demonstrated that the inefficiency of ESMP implementation follow-up goes beyond the absence of legal texts organizing the activity. Other reasons associated are the lack of ESMP implementation follow-up on the part of the administration due to the lack of financial resources allocated to monitoring missions for the MINEPDED and the unavailability of validated environmental monitoring and compliance methodology for the different industry sectors. These views on the issue of environmental monitoring and compliance of certain projects in Cameroon reveal that much remains to be done.

Though it will be unfair to state that extractive industries do not make efforts towards the implementation of ESMP, however it is an exaggeration to say ESMPs are properly implemented in this sector (WWF, 2013). While companies in exploitation take ESMP implementation as a priority, companies in exploration are often reluctant. In terms of environmental performance, an Exploration Company (Kosmos Energy Cameroon HC) displayed the highest standards of diligence during ESMP implementation while maintaining a first, second and third party follow-up scheme. Apart from efforts made by COTCO in the implementation of the different volumes of ESMPs of the Chad-Cameroon Pipeline project; where an External Monitor and an internal team of about 20 people are assigned to the implementation of the volumes of the ESMP, it is rare to find such a dedicated team in charge of ESMP implementation for projects of the extractive sector in Cameroon. In terms of the latter sector, at Kosmos Energy HC Cameroon a dedicated team made up of an International Environmental Expert, 3 national environmental Experts (with one acting as supervisor) and an External Affairs director were all assigned to oversee activities.

3.4. Deficiencies in ESMP follow –up in the Extractive Sector

The main deficiency observed during ESMP follow-up in the extractive industry is related to a lack of awareness and commitment on the part of company Management. Also, the absence of a generalized or sector specific methodology for the monitoring of effects, compliance and performance plays a major role in poor performance. More than 60% of reports reviewed revealed absence of information on Waste volumes, Carbon –foot prints calculations, general incident records and trends…

4. CONCLUSION AND RECOMMENDATIONS

In order to ensure effective ESIA follow-up and compliance much needs to be done; firstly, assurance of IA to actually address the issues of compensation; secondly, assurance that stakeholders are knowledgeable on the mitigation hierarchy and thirdly, that environmental compensation measures are put in place and followed up to see they effectively enhance environmental benefits. Initiatives put in place must also therefore address the lapses in the ESIA evaluation criteria, ESIA outcomes and ESMP follow-up. Furthermore, the capacities of various stakeholders involved in the process must be equally enhanced to guarantee effectiveness of the process.

The national criteria for the evaluation of impact assessment are very elaborate, however, they do not provide a rating to determine the degree of accuracy of the information required. It neither emphasizes the respect of the mitigation hierarchy nor makes provisions for Environmental Compensation. There have been recent improvements in the quality of EIA reports, but emphasis need to be laid on active public participation, publication of research work and the availability of climate data. Also, there is need for peer review to be considered in the ESIA process to guarantee the quality of the report. Such review should be sponsored by Government and not by proponents.

In terms of ESIA/IA follow-up methodologies, companies are not properly guided on reporting standards, hence reports on the implementation of ESMP in most cases failed to address the key environmental issues in their respective sectors.

However, companies operating within the same geographical or ecological regions could collectively come together and join resources to compensate for residual and/or cumulative impacts, which impose the need for Cumulative Effects Assessment to be highlighted by the Cameroon IA regulations.

REFERENCES

Business and Biodiversity Offsets Programme (BBOP). 2009. *Biodiversity Offset Cost-Benefit Handbook*. BBOP, Washington, D.C.

CIME & CSIR, 2013: ESIA for 2D Seismic Survey Operations, Bakassi West Block, Dana Petroleum Cameroon .

Nguene Francois Roger, Fonocho Charlotte Enjoh, Juliet Taza-Asaba Lebongwo&NienNgapout Suzanne-Aimee, 2012: *Role and Level of Stakeholders Involvement in the EIA Practise In Cameroon*: Case of EIAs of the Upstream Energy Sector.

Peters, W., Siewert, W. & Szaramowicz, M. (2003) *Folgenbewältigung von EingriffeniminternationalenVergleich*, BfN-Skripten 82, BundesamtfürNaturschutz, Bonn.

Price water house Coopers LLP. 2010. *Biodiversity Offset and the Mitigation hierarchy*: A Review of current application in the banking sector. A study completed on behalf of the Business and Biodiversity Offsets Programme and the UNEP Finance Initiative.

UNEP, 2002: *Environmental Impact Assessment Training Resource Manual*. Second Edition 2002.

WWF 2013: A Study on the Application of Environmental Compensation as a Tool in Mitigating Adverse Effects on the Environment in Cameroon. Case of the extractive industries.

www.eia.doe.gov

Integrating climate change into the environmental assessment process: what is the situation in African Francophone countries?

TCHINDJANG Mesmin
University of Yaoundé I, Geography Department. PO BOX 30464 Yaoundé
mtchind@yahoo.fr, tchindjang.mesmin@gmail.com

Introduction

Climate change (CC) creates negative perverse impacts requiring appropriate action. However, populations and productive systems in many developing countries are highly dependent on natural resources and often have a relatively limited adaptive capacity. Rain – fed agriculture in these countries is more dependent on the climate. As a result, these countries are often among those most affected by climate change. While the need for action has been clearly recognized by the entire development community, the debate on how to integrate climate change into the development practice and initiatives still has a long way. Environmental assessment (EA) thus appears as a tool for integrating climate change into decision-making. Indeed, the impacts of global warming on territories, resources and lifestyles are unprecedented and still poorly controlled. Least developed countries (LDCs), developing countries and small island states are the most affected with the increase of natural risks and disasters, water stress, desertification, rainfall modification.

In the francophone sub-Saharan Africa (SSA) countries, the situation is quite complex because of many bottlenecks and impediments in integrating issue of climate change in the EA processes, among which:
- Poor knowledge on the topic and uncertainty about the local impacts of CC;
- The thorny problem of funding for adaptation (insignificant in agricultural domain);
- The fuzzy limit between development and adaptation;
- The difficulty of analyzing vulnerabilities and adaptive capacity locally (because of illiteracy, lack of sensitation and capacity building);
- The real control of EA processes itselves by governments and NGOs.

Nevertheless, this paper will take support on three main situations both theoretical and practical.

1. Development planning documents and reports

Theoretically, the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment (2003) stated that the EA practitioner should carry out an in-depth analysis of the CC's impacts range and determine the level of confidence that may be attributed to the data. Also, integrating CC considerations into EA can help determining the project's compliance with GHG measures, including national adaptation and government plans on CC. Integration can help proponents adopting best practices that promote and facilitate CC adaptation, including changes in the frequency and intensity of extreme weather events, average temperature rises and changes in rainfall patterns. However, despite the expected massive reduction of GHG emissions in the near future, changes in climate conditions will continue to occur and the extent of its impacts will increase significantly in the future. For this reason, the paper will emphasize on three main practical issues.

2. Strategies, plans and programs documents

Since the ratification of the United Nations Convention on Climate Change (UNFCCC), most African French-speaking countries have tied to the international evolution of the global climate situation, as can be seen from several documents relating to CC. They used environmental assessment methods and tools, including a participatory approach in writing and disseminating policies and planning documents, namely:

- Vision 2020, 2025 or 2035; are important national planning and development documents issued by each country. Such documents should be extended to

economic growth strategies and plans as well as national action plans to fight against desertification (PAN-LCD/NAP-FAD)

- Second national climate change communications (SNCC), National Adaptation Program of Action (NAPAs), National Adaptation Plan for Climate Change (NAPCC), Nationally Appropriate Mitigation Actions (NAMAs), Reducing emissions due to deforestation and degradation (REDD+), Monitoring – Reporting – Verification (MRV) and Intended Nationally Determined Contributions (INDC). These reports are based on GHG emissions, climatic risk and vulnerabilities.

Lastly, the above strategic documents are drawn up with a broad vertical and horizontal consultation (bottom-up and top-down). Its cover key vulnerable sectors (agriculture, water, coastal areas or health) and on cross-cutting issues on CC, including adaptation and mitigation measures. Its validation is done after public participation (local population, donors, NGO, Governments and stakeholders).

3. Climate Proofing for Development of the GIZ (German Technical Cooperation)

"Climate Proofing for Development" (CPDev) is a tool built by German development cooperation (GIZ), and designed to support the integration of CC impacts and reducing its risks (Hahn & Fröde, 2011). It is a methodological approach that aims at incorporating CC issues into development planning; raising awareness of the CC challenges and opportunities as well as more effective and resilient measures.

The tools started by project screening before extended to options practices that are common practices in environmental assessment. This explain why CPDev can be used at different levels, being national (cross-sectoral policies, development plans, budget), sectoral (policies, strategies, investments programs), local (municipal plans, land-use planning) and project level (projects and programs). As for EA, CPDev appears to be a multiusers tool involving stakeholders, public authorities, national and international organizations, donors, NGOs, associations and private sector. The following paragraphs describe two cases of adaptation (agriculture) and mitigation (energy) related to the CPDev field application.

SSA countries practice rain fed agriculture vulnerable to CC. Due to poor climate finance, African continent agriculture is the less responsible for CC while being the most vulnerable (Dupoux & Zrikem, 2016). CPDev was successfully applied in Morocco, Mali, Togo and Burkina Faso agriculture using EA approach with four main steps (preparation, analysis, options for actions and integration). For example, in the humid and subhumid agricultural areas (Togo, Cameroon), excessive rainfall lead to the proliferation of insect pests such as mirids and the emergence of plant diseases like the necrotic decay of the coffee tree, the swollen shoot and the brown rot for the cocoa (Amougou et al, 2013). It attacks the root system of plants, leading to the wilting of these crops. In the dry regions of SSA (Mali, Senegal, Burkina Faso, Northern Cameroon), cereals (maize, millet and sorghum specifically) are particularly vulnerable due to their high sensitivity to water stress, resulting in productivity decline and reduction in food supply. Such a situation leads to the surge in prices and food starvation/insecurity. The above results give way to issue a CPDev manual / guide for Sustainable Land Management projects and programs in those countries.

According to Maurice Strong[1] ", we must treat climate as a security issue, the most important threat to global security we will ever face. Energy is at the heart of this transition. Climate security and energy security are two sides of the same coin: one cannot be achieved without the other." Food security matches with energy availability. **Energy sector** representing the major producer of GHG emissions through fossil fuel combustion, is also vulnerable to CC

[1] Maurice Strong is the former Secretary General of the UN Conferences – Stockholm (1972) and Rio (1992).

impacts. Given the inextricable link between socio-economic development and access to energy, it is clear that any approach to securing development in the context of a changing climate must consider the adaptation needs of the energy sector. Weak energy systems constrain efforts to reach the sustainable development goals. For instance, energy is essential in reducing disease levels and consequences. Clean energy (solar, biomass, biogas) can reduce SSA traditional wood burning and related respiratory deadly diseases as described by WHO (2007).

It is known that changes in temperature affects biomass growth and distribution which impacted quantity and quality of animal fodder and crops, material for human shelter, heating, fuel agriculture, electricity generation, health and sanitation. Also, changes in rainfall patterns influences agriculture, electricity generation, health and sanitation. Given the clean and efficient energy's role in economic development, it is crucial to reduce energy system vulnerability while increasing system resilience. In this light, HELIO international (2009) developed a straightforward methodology with a set of indicators to assess the vulnerability and resilience of national-level energy systems to CC via EA tools and CPDev. HELIO succeeded in identifying policies and measures able to easier and support adaptation activities. After analyzing energy problems within 10 SSA countries (Benin, Burkina Faso, Cameroon, D.R. Congo, Kenya, Mali, Nigeria, Senegal, Tanzania, Uganda) in four domains (Hydropower, biomass, Wind and solar energy), HELIO concludes that these countries are directly impacted by changes in rainfall and temperature level.

According to HELIO (2009), adaptation measures can be categorized into infrastructural/technical and behavioural/social responses.

- Technical adaptation tries to make infrastructures less vulnerable against long-term changes in meteorological variables and extreme events.
- Behavioural adaptation adjusts the operation of the infrastructure (both existing and new) and the siting of new infrastructures to minimize damages.

Lastly, Helio International (2009) report summarizes anticipated climate-induced impacts on key energy systems and outlines possible adaptation measures, proposing eight recommendations to help reinforcing the resilience of energy systems.

1. Systematically assess and monitor energy systems to ensure that they are robust enough to adapt to anticipated climate-related impacts.
2. Expand the current assessment process for new energy systems (solar, biogas, etc.).
3. Develop a medium to long-term strategy to move toward a safer, decentralized, low-carbon energy supply system.
4. Implement energy demand management as an adaptation measures.
5. Cultivate in-countries capacity to evaluate and respond to energy needs from a climate perspective.
6. Invest in ecosystem services that support existing and planned energy production.
7. Establish transparent technology transfer and financing procedures.
8. Develop participatory energy governance to cultivate first-hand knowledge of energy needs while mobilizing vital support from beneficiaries

4. Green Sahel Operation (Cameroon).

In the Northern Cameroon cities, (Garoua and Maroua), population frequently use firewood for household purposes. According to Ntsama Atangana et al. (2010), more than 94% households use firewood, 90% charcoal and 64%, wood. Wood consumption is more than 12 times the amount of gas used by households with an average, of 2–3 kg/day individual wood requirement per inhabitant. The anarchical way of collecting firewood provokes huge pressure on this resource. This situation has brought the Cameroon government to relaunch the Green Sahel Operation in this environmentally sensitive dry region characterized by poor farming practices and overgrazing (Tchindjang et al, 2012). After an environmental audit of former projects, population (more than 80%) were sensitized through awareness campaign

an awareness campaign in the implementation and monitoring of afforestation program to stop the desert's advance. This participative project using EA methods aims at preventing and reducing the semi-arid and dry lands degradation, and then restoring degraded soils. It also contributes to restore and improve the fertility of degraded and marginal lands, to strengthen this sahelian vegetation cover, to discourage the firewood cutting. Lastly, the project distributes improved cooking stoves to stakeholders and raises public awareness against desertification.

As findings, there was a return of wildlife and a revival of economic activities related to non-timber forest products (NTFPs). The remaining problems to solve were bush fires, vandalism, deferred grazing, nocturnal pasture and the lack of species signaling on different sites. The afforestation project describes sounds like the best approach in the fighting against desertification. For, it appears to be the most effective response incorporating complementary processes such as water conservation, soil retention, reducing the runoff, fighting against wind erosion and bush fires.

Another program was since 2013 by UNDP (PNUD, 2016) through landscape analysis. Local communities are central in this adaptation strategies which enable the re-greening of the Sahel and afforestation of the school yard by pupils.

Discussion and recommendations

Overall, the above listed strategy documents have integrated adaptation to the various stages of the national policy cycle (policy formulation, planning, allocation and resource mobilization stakeholders identification and mobilization). Thus, SSA francophone countries ratified UNFCCC Convention, but, the CC assessment parameters are not yet included in the these various countries legislation, resulting in a lack of legal constraints. However, best practices at the grassroots level help to correct this gap. This is the case with CPDev approach, which is integrative, participatory and flexible. Moreover, this tool really does not need standardized knowledge and it enables a strong ownership. It also improves the participation of vulnerable communities in valuing traditional knowledge and local know-how in spontaneous adaptation.

Lastly, the CPDev in agriculture entirely joins the program launched at the COP 22 on the Adaptation of African Agriculture (AAA) to CC. African Agriculture Adaptation initiative aims to reduce the vulnerability of Africa and its agriculture to CC (AAA White paper, 2016). HELIO International also uses CPDev in improving energy systems and availability in SSA.

Conclusively, best practices in integrating EA into climate change adaptation lead decisively to the following aspects.

- More resilient ecological agriculture with efficient and integrated agro-pastoral systems for food security.
- More resilient agricultural and biophysical landscapes.
- Better ecosystems protection and biodiversity conservation.
- Fighting against desertification.
- More resilient and smart investments (not only in ecosystems services).
- More resilient economies.
- Energy sources diversification and production with best technologies.
- Participatory energy governance bringing populations and beneficiaries to good ownership.

Conclusion

The Climate change evidence requires appropriate actions. Biophysical and socio-economic impacts that aggravate existing development problems are: water shortages, floods, heat waves, biodiversity loss, electricity production shortage, population migration, population

conflicts and health risks. The integration of EA tools and CPDev approach into planning is a real fact in SSA. Notwithstanding the existence of environmental regulation in each country, there is a lack of a permanent framework, integrating adaptation, including CC law and regulations governing the coordination of institutions. Nevertheless, the establishment of national climate change observatories is also a good practice that supplements this regulation gap. Moreover, CPDev integration into the EA process becomes a successful story and effective substitute.

References

AAA (2016). The *Initiative for the 'Adaptation of African agriculture to Climate Change. AAA White paper*, 15p.

Amougou J.A., Tchindjang M., Abossolo S.A. & Batha R.A.S., (2013). A comparative study of the influence of climatic elements on cocoa production in to agrosystems of bimodal rainfall: case of Ngomedzap forest zone and the contact area of forest savanna of Bokito. *Journal of Cameroon Academy of Sciences (JCAS) Vol 11 N° 1, pp. 27-37.*

Dupoux P. & Zrikem Y. (2016). L'adaptation de l'agriculture africaine » est « une priorité . Journal *Le Monde* of 09 /11 /2016.

Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment (2003). *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners. CEAA, 44p.*

Hahn M & Fröde A. (2011). *Climate Proofing for Development. Adapting to Climate Change, Reducing Risk.* GIZ, Eschborn, 36 p.

Helio International (2009). *Climate proofing energy systems*. 56p.

Ntsama Atangana J., Tchindjang M**.,** Moulende T., Bene Bene C. L. (2010). Evaluation environnementale de la problématique de bois de feu dans la vile de Garoua Nord Cameroun.
http://www.sifee.org/Actes/actes_paris_2010/Communications/BLOC_4/S_4.1/3_NTSAMA_ATANGANA_TXT.pdf

PNUD, (2016). *Rapport de l'Évaluation Ex-Post de la situation de référence du paysage du projet « Développement Communautaire et de Gestion de Connaissances pour l'Initiative Satoyama (COMDEKS) ». Arrondissement de Bogo, Région de l'Extrême-Nord, Cameroun*. Yaoundé, 106 p.

Tchindjang M., Amougou J.A., Abossolo S.A. & Bessoh Bell S. (2012). Challenges of climate change, landscape dynamics and environmental risks in Cameroon. In Landscape Evolution, Neotectonics and Quaternary Environmental Change in Southern Cameroon: *Palaeoecology of Africa*, 31, Ch.5, pp. 237-286. Taylor and Francis, London.

WHO, (2007). *Indoor Air Pollution*: National Burden of Disease Estimates.

SALTWATER INTRUSION IN THE BAIE DE RUPERT, JAMES BAY, CANADA

Alain Tremblay and **Carine Durocher**
Hydro-Québec, 75 Boulevard René-Lévesque, Montréal, Québec, Canada H2Z 1A4
Contact : tremblay.alain@hydro.qc.ca

Background

As part of the Eastmain-1-A, Sarcelle and Rupert Diversion Project, a portion of the flow of the Rupert River was diverted to the Eastmain 1 Reservoir (Figure 1), through a series of diversion canals and tunnels. As a result, hydropower production at some of the powerhouses of the James Bay Complex has increased significantly. An environmental flow regime is provided at the diversion dam (Rupert dam) to preserve fish habitats and to mitigate the impacts on the environment. The discharge of the Rupert River at its mouth into Rupert Bay is thus reduced an average of 50% annually.

Rupert Bay receives the inflow of four major tributaries, the Nottaway, Broadback, Rupert and Pontax rivers. The decrease in the Rupert's discharge corresponds to an 18% decrease in the total freshwater inflow to the bay. The potential impacts of this change have been the subject of specific studies conducted as part of the Eastmain-1-A—Sarcelle—Rupert project's environmental impact assessment (EIA). Based on oceanographic data collected from 1975 to 2003 as well as numerical models, the impacts of the diversion on water levels and the intrusion of saltwater within the bay were assessed (Hydro-Québec, 2004). It was predicted that the upstream limit of the saltwater intrusion would shift 5 km upstream during ice-free periods, and slightly less in winter when ice cover is present.

In the project's conditions of authorization, monitoring the hydraulic conditions and the extent of saltwater intrusion in the Rupert Bay after the diversion of the river was required by Québec's *Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs* (MDDEFP) and by Fisheries and Oceans Canada. As part of the project's monitoring program, river discharge data, water levels in the bay as well as meteorological data must be collected during the 2008 to 2017 period. In addition, specific oceanographic data, including current and salinity measurements, are to be collected in 2010, 2013 and 2017. Here we present data collected in 2010 and 2013 and the interpretation of additional available data (Environnement illimité, 2011, Consorsium Waska-Genivar, 2014).

Objectives

The general objective of this study is to validate predictions made in the EIA in terms of modifications of oceanographic (salinity gradient) and hydraulic conditions (water levels) in the Rupert Bay and Estuary, as well as at the mouth of the Pontax River.

Specific objectives are:

- to determine the upstream saltwater intrusion limit in Rupert Bay in 2013, in ice-free and ice cover conditions;
- to compare the saltwater intrusion limit and water levels in the estuary and the bay to those prevailing before the diversion, to those predicted in the environmental impact assessment and to those observed during the first year following the diversion;
- to evaluate currents and saltwater intrusions in the Pontax River in 2013 and compare the results to those obtained before and after the diversion.

Cree Knowledge and Participation

As part of this study, Cree workers from the Waskaganish community provided technical assistance during the surveys at sea. The workers were experienced Cree land users of the area who had an interest in the saltwater intrusion issue, some of them are fishing in sites such as the mouth of the Pontax River and the islands bordering the entrance of James Bay. Their knowledge was collected using a combination of both passive and active methods.

Figure 1: Location of the study area

Methodology

The saltwater intrusion limit in Rupert Bay was assessed based on two field surveys in the bay in 2013. Hydraulic conditions were assessed based on the analysis of time series of hydrological, sea water level and meteorological data collected on an ongoing basis since 2008.

Oceanographic Surveys

The intrusion of saltwater was assessed in conditions favorable to a deeper incursion of the saltwater front within Rupert Bay, such as:

- the winter and summer baseflow periods, when freshwater discharge is minimal; and
- spring tides, which occur twice a month and when the inflow of saltwater to the bay is higher.

Both in winter and summer, four moorings, each comprising an ADCP[1] current meter and two CTD[2] probes, were installed for periods of 35 to 49 days, comprising two spring tides, during which saltwater intrusion is at its maximum. In addition to the data recorded at the moorings, discrete measurements were made simultaneously by two or three teams at specific stages of the tide cycle. These measurements aimed at precisely locating the maximum limit of the saltwater intrusion at high tide as well as its maximum recession at low tide. To chase the salinity front during the tide cycles, the teams used helicopters (Photos 1 and 2) and boats. The measurements included vertical profiles of salinity, temperature and current direction and velocity.

1 ADCP : Acoustic Doppler Current Profiler
2 CTD : Conductivity, Temperature, Depth

Photos 1 and 2: *Surface buoy marking a mooring station (left), Locating the saltwater front near the shore by helicopter (right)*

Data Analysis

In general, the salinity of natural waters ranges from practically 0 in freshwater to approximately 36 PSU[3] in oceans. In this study, the saltwater intrusion limit was defined using a salinity limit of 0.5 PSU.

The analysis of the salinity data from the moorings consisted in identifying the periods when the salinity exceeded 0.5 PSU for a period of at least 6 hours (approximately half a tidal cycle). The data from the discrete measurements along the west and east channels and near the shores were mapped so as to locate the limits of saltwater intrusion and recession separately during the winter and the summer baseflow. The intrusion limit corresponds to the furthest upstream location where salinity exceeded 0.5 PSU. Conversely, the limit of recession corresponds to the furthest downstream location where a salinity lower than 0.5 PSU was recorded.

Meteorological and Water Level Data

Data collected since 2008 at the monitoring stations were also analysed to provide a statistical description of the meteorological conditions (air temperature, pressure and wind), water levels in the bay and discharge of the major tributaries. This data was validated and completed as required using statistical procedures. Water levels in the bay were the subject of a specific analysis aimed at understanding the importance of different components of the tide cycle (e.g. lunar and solar components) and the influence of meteorological perturbations on water levels in the bay. Finally, water levels in the estuary in post-diversion conditions were assessed.

Results

Saltwater Intrusion

During the summer survey, the upstream saltwater intrusion limit was located slightly to the south of Jolly Islands, on the east shore, and approximately 4 km to the south of the mouth of the Octave River on the west shore (Figure 2).

Near the centre of the bay, the intrusion limit was approximately 4 to 6 km further upstream compared to pre-diversion conditions. The position of the front was within the area predicted in the environmental impact assessment (EIA), which appears to be conservative. Compared to the low hydraulicity conditions observed in 2010, after the diversion, the limit in 2013 was approximately 2 km downstream. The location of the front in 2013 was thus intermediate between the position observed in 2003 and 2010. It is apparent that the incursion of saltwater in the channels decreases with the total discharge of freshwater into the bay. Lower discharges thus favour a deeper incursion of the saline front.

Near the shores, the pattern is somewhat different and more complex. The limit of the saline front near the shores does not appear to be driven solely by the freshwater discharge in the bay but is also influenced by meteorological

[3] PSU : practical salinity units

conditions such as atmospheric pressure and wind. There is thus considerable variability in the position of the front from year to year (Figure 2).

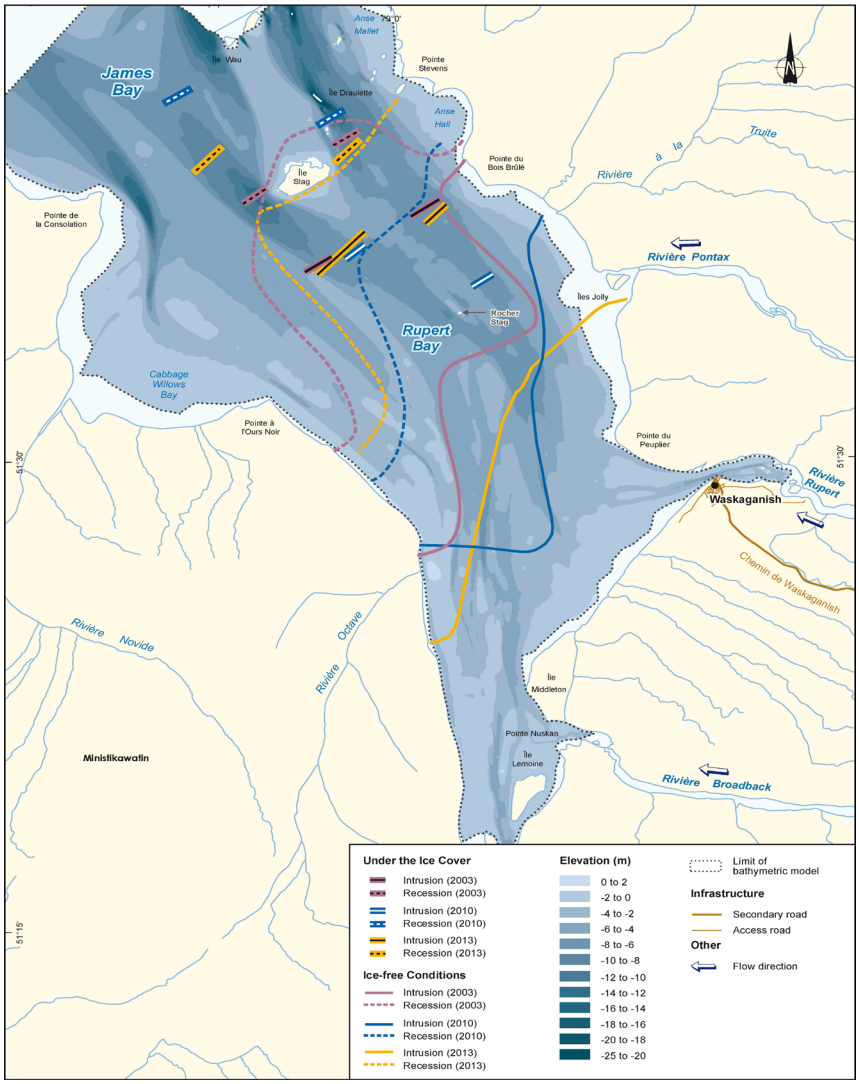


Figure 2: Measured limits of salt water intrusion in open water and ice cover conditions

In the estuary, near Waskaganish, no saline intrusion was observed in post-diversion conditions in 2010. This result is consistent with the prediction of the EIA.

At the mouth of the Pontax River, one episode of saline intrusion was observed in 2013, compared to 8 in 2010. These intrusions are correlated with strong winds from the west to north sectors and are more likely to occur when the discharge of the Pontax River is low, e.g., at the end of winter and summer. The effect of wind indicated by the statistical analysis is coherent with the knowledge of the Cree workers who participated in the study.

During the winter baseflow, when the bay is covered by ice, the incursion of saltwater is greatly limited compared to ice-free conditions. The limit of the front was located 10 km or more further downstream (Figure 2), near Stag Island. The smaller incursion was likely caused by the absorption of part of the tidal energy by friction with the ice cover. The saline front was relatively close to the position observed in pre-diversion conditions but a few kilometres downstream from the 2010 position.

Water Levels

In the bay, water levels appeared to be generally similar from year to year, with some fluctuations that most likely be explained by meteorological events such as storm surges, especially in summer and to a lesser degree in winter. No difference between pre- and post-diversion conditions could be related to the decrease in the discharge of the Rupert River (Figure 3).

In the estuary, the diversion was expected to cause a slight drop in water levels. A decrease was observed mostly at low tide, with no change observed at high tide. On average, the water level in the estuary was 10 to 15 cm lower than in pre-diversion conditions. This result is consistent with the EIA's prediction.

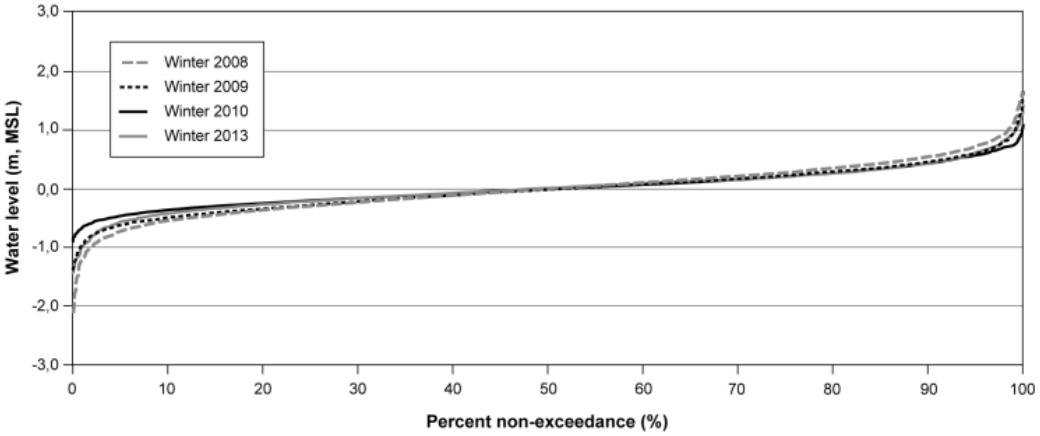


Figure 3 : Non-exceedance stage curves at Stag Rock Station for ice-cover conditions during 2008, 2009, 2010 and 2013

Conclusion

Rupert Bay is a singular site being a large estuary with very shallow depths that receives large volume of freshwater inflow from three major rivers on its eastern boundary and where tidal forcing and weather conditions play a major role in water level variations.

In order to improve knowledge of Rupert Bay hydrodynamics and to understand and measure the impacts of the diversion of one of its major tributaries on salt water intrusion and the limit of these zones, more than 15 studies, combining oceanographic and hydrological measurements to numerical modelling, were conducted since 1977.

Monitoring, undertaken in 2010 and 2013 relying exclusively on empirical data collected both in open water and ice-cover conditions, confirm predicted trends. Measured changes remain in the range anticipated by the EIA. This highlights the good overall performance of the impact assessment and validation process, where the impact of the diversion was first predicted with an acceptable level of precision and was confirmed and refined post-diversion only using empirical measurements during two years of operation of the project.

References

CONSORTIUM WASKA-GENIVAR, 2014. Centrales de l'Eastmain-1-A et de la Sarcelle et dérivation Rupert. Suivi de l'intrusion saline dans la baie de Rupert. Rapport d'étude 2013.

ENVIRONNEMENT ILLIMITÉ INC. 2011. Centrales de l'Eastmain-1-A et de la Sarcelle et dérivation Rupert. Suivi de l'intrusion saline dans la baie de Rupert et la rivière Pontax. Rapport d'analyse 2010.

HYDRO-QUÉBEC. 2004. Centrale de l'Eastmain-1-A et dérivation Rupert – Étude d'impact sur l'environnement – Volumes 1 à 9.

Empowering Indigenous groups with baseline data collection

Mariana Trindade

Abstract:

Following a period of absence of active mining, the Labrador Trough region currently hosts numerous proponents who will be required to establish baseline environmental conditions for their project areas. A portion of the Labrador Trough is also located on or near Innu and Naskapi communities, which have experienced the adverse environmental effects of iron ore mining activities on their land and traditional practices for several decades and will likely continue to experience effects due to future anticipated waves of mining projects in the region.

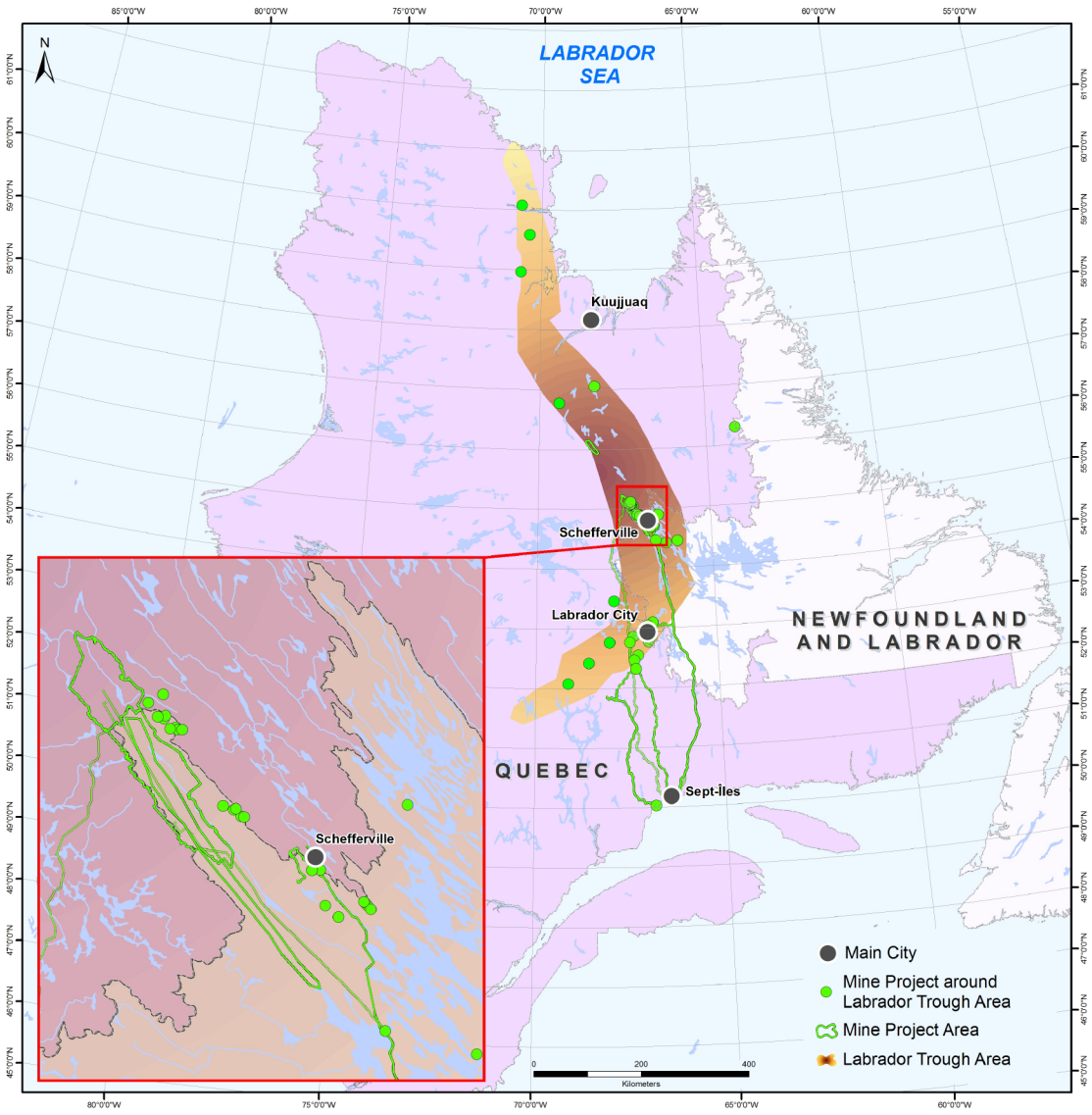
Baseline data is subject to seasonal time restrictions, time constrictions in establishing local knowledge and trends (i.e. climate data), which can take years to compile. Simultaneously, the arrival of large conglomerates can overwhelm locals, who have the best knowledge of local conditions and struggle in the middle of a complex program.

To empower Indigenous groups in their relationship with Promoters, we suggest a training program to collect environmental baseline data in accordance with Environmental Assessment (EA) standards, which can benefit locals and promoters alike. Whereas the former will benefit from: a training program, a better understanding of the EA process, and increased confidence in the process, the latter will benefit by: reducing costs and acquiring a more complete dataset, thus disentangling the relationship between Indigenous groups and promoters.

The setting

The Labrador Trough is a 1,600 km long and 160 km wide region that straddles the Quebec and Labrador border and extends from approximately 51°N to 58°N (see Figure 1). It was characterized in the 19th century by Father Babel, a Jesuit missionary-explorer who travelled in the region in the 1860s, and A.P. Low of the Geological Survey of Canada, who recognized the region's potential for large deposits in the 1890s. At that time, interest in mining was limited due to the remoteness of the site (Clark, 2011; GSNL, 2012). It would take three decades for development to commence in the area, once iron-rich direct-shipping ore was discovered.

In 1954, the town of Schefferville was established by the Iron Ore Company of Canada (IOCC) to support mining activities in the area. At this time, Innu from Maliotenam and Naskapi from Fort Chimo (1956) resettled to Schefferville to assist with exploration work and the railway construction. At its peak in the late 1960s, Schefferville counted some 5,000 residents. By 1972, housing units had been built, and most of the Naskapi and Innu moved to this new site, known today as the Matimekosh Reserve.



Local mining activities ceased in 1982 due to economic difficulties and increased competition. At this time, most of the 4,000 or so non-aboriginal occupants left, leaving mostly aboriginal people who had settled there in the preceding 30 years. As a result, in 1986, the town ceased to exist as many of the existing infrastructures were destroyed by IOCC in order to avoid paying property taxes, and social amenities disappeared. Some houses and public facilities were demolished, while other parts of the infrastructure were added to the Matimekosh Reserve. However, the Indigenous population remained and the town reverted to an incorporated legal entity in 1990.

As a result of these past activities and the fact that, historically, mining companies were released from their projects without the requirement for any site rehabilitation, some areas within the region have become permanently altered.

The biological destruction in the area combined with the economic strains on the nearby communities have resulted in deep-rooted frustration with the mining industry, including the associated regulatory processes. In the context of the EA process, the convolution of several levels of jurisdictions (federal, 2 provincial governments and municipal) straddling the region has led to confusion and frustration, largely over the lack of control over resources and adverse environmental effects on the land.

Since several of these future projects may trigger an environmental impact statement (EIS) via the *Canadian Environmental Assessment Ac*t (CEAA 2012), the region is therefore expected to continue to host proponents who will be required to establish baseline environmental conditions for sites within the Trough.

Environmental Assessment Process

In the context of an EIS, baseline data collection is a crucial first step to understanding pre-project conditions, onto which an eventual effects assessment can be based. In remote regions such as the Labrador Trough, historical data is scarce and largely insufficient to support and EIS. The establishment of baseline conditions can be an arduous process for proponents, especially in remote settings, as it is subject to seasonal time and climate restrictions, which may lead to frequent fly-in fly-out trips, time constrictions (proponent may be pressured to complete this first step rapidly) in establishing local knowledge and trends (i.e. climate data), all of which can take years to compile. Local land users have the most at stake from the implementation of metal mining projects, and the accurate and the thorough completion of the associated EIS documents, and are in the best position to provide information on the current state of the local environment.

To empower indigenous groups in their relationship with promoters and different levels of governments, we suggest that a training program to collect environmental baseline data in accordance with EIS standards, which can benefit locals and promoters alike, be implemented. Whereas the former will benefit from: a training program and a better understanding of the EIS process via active participation, the latter will benefit by: reduced costs and acquiring a more complete dataset, thus disentangling the relationship between indigenous groups and promoters. Further, as is often proposed by authorities, frequent and early communication with local stakeholders is key to developing a good relationship: such a training program would ensure this type of partnership.

For metal mining projects in Canada, there are eight components which are regularly assessed under the EIS process, and therefore require that baseline conditions be established. They are grouped below by sampling effort. Underlying all of the scientific methods that are proposed below is the potential for information on local land use, which is a valued component in itself,

and who's analysis must consider information from the eight biophysical components described below.

Atmospheric environment: aambient air quality, noise, light and climate.

Indigenous groups can provide the information required to fulfill baseline requirements for these components by: 1) proposing sensitive locations (camps, religious and sacred sites) for sampling and 2) recording data points throughout the year to present a complete description of the atmospheric environment. Further, oral histories of changes to these components can provide long-term data which can be used in an EIS document.

Geology, geochemistry, topography, surface and groundwater

The description of these components usually requires the participation of a specialist to carry out data analysis (ex: geographic information systems) and modelling work to fully describe their baseline conditions. None the less, local land users can provide information on water sources used by the community and locations of interest (ex: areas of groundwater resurgence, specific areas used by the community – mountain, river) which should be targeted by the proponent.

Terrestrial environments

The establishment of the baseline conditions of terrestrial environments usually requires that a significant amount of mapping and field surveying be completed to produce, for example an Ecological Land Classification map. The proponent may choose to base its baseline description on literature, in which case indigenous groups could still participate via ground truthing and field validation exercises. Training could be required to apply protocols for such analyses as wetland assessments and soil classification descriptions. Consultations with berry pickers/harvesters may also provide an added-value to the usual flora surveys.

Fauna: fish and fish habitat, avifauna, wildlife

Incidental terrestrial wildlife sightings by local land users and consultation with hunters and fishermen are easily tabulated and these data would provide an indication of population characteristics, locations and habitat preferences, which may provide an added-value to the usual fauna surveys required for the evaluation of baseline conditions. Training may be required to complete more thorough surveys, if needed (e.g. if species is known to be at-risk), and for avifauna.

Aquatic fauna is usually assessed via field work. Sampling can include common methods such as angling. Training would be required on how to effectively describe fish habitats (morphometric, hydrometric and limnological) as well as how to collect biological data from live samples.

Human Health: drinking water sources and consumption of country foods

For this component, pre-project conditions should be described as country food consumption habits followed by an evaluation of the level (if any) of contamination in those foods. This latter step is particularly important for an area like the Labrador Trough, where past projects may have had adverse environmental effects on the environment. For the Proponent, the human health component is made difficult because land users are not always available to complete survey (or may be experiencing survey fatigue, especially in an area that is expected to host numerous projects). Furthermore, the country foods to be targeted need to be present at the time that a sampler is available on site (some country foods migrate, or are only available at certain times of the year).

We suggest that a survey be prepared by the proponent, in assistance with local land users, and that a local person is ideal for carrying both, survey and sampling, as a survey implemented by locals can be more representative of the local population and that all country foods can be sampled, in time, for contaminant evaluation. Training would be required on how to handle samples for analysis, which could then be easily shipped to for laboratory analysis.

General suggestions and development of a firm

We suggest that a local representative be in constant contact with the proponent to develop the baseline conditions for a metal mining project. Although for several field surveys-types, training would be relatively straightforward, for other additional tools, such as mapping using geographic information systems, the knowledge can be transferred in time to indigenous groups. Eventually, it is expected that this contact person could become an established business venture which remains in the community. This 'firm' could eventually offer monitoring and follow-up services and assist in the rehabilitation process of the mining activities. Depending on the experience of the selected local resource, a trained specialist can accompany the resource on site.

We also suggest that, in the context of such a large-scale region as the Labrador Trough, indigenous groups acquire the instrumentation that is necessary for baseline data collection (in situ monitoring stations for air, noise and light, water quality sampling instruments, for example). In time, the acquisition of this equipment (which may be funded), would allow local groups to gain independence from a single company and offer services to a broader clientele.

The intimate knowledge of the baseline data that goes into a complex document such as an EIS would allow indigenous groups to more effectively navigate through the EIS process in general. We suggest that the Labrador Trough, by virtue of its size and potential for numerous large-scale projects, is an excellent opportunity to develop a training program that will be used repeatedly.

References

Canadian Environmental Assessment Act (2012). S.C. 2012, c. 19, s. 52.

Clark, Thomas (2011) The Legacy of Iron: Schefferville, Québec, Canada. GeoScience World, April 2011: 7(2). P. 144. http://elements.geoscienceworld.org/content/gselements/7/2/144.full.pdf

Geological Survey of Newfoundland and Labrador [GSNL] (2012) Mineral Commodities of Newfoundland and Labrador Iron Ore Number 7. Department of Natural Resources. 15 pages. http://www.nr.gov.nl.ca/nr/mines/investments/IronOre.pdf

Naskapi community website: http://www.naskapi.ca/en/History

Conflicts and social impacts: EIA of renewable energy

Sanne Vammen Larsen, Anne Merrild Hansen, Helle Nedergaard Nielsen, DCEA - Aalborg University, Denmark

Abstract: The transition to renewable energy is currently challenged by conflicts over specific projects. For example siting of onshore wind turbines often causes conflicts with local communities, sometimes leading to abandonment of the project. This paper presents an analysis of such conflicts, and the role of social impacts. The paper analyses four cases of renewable energy projects, using a conceptualization of conflict constituted by three elements: Attitude, behaviour and contradictions.

Introduction

In later years there have been many examples, where implementation of renewable energy (RE) leads to conflicts with local residents. Notably, wind turbines have been known to cause conflicts with local communities (see e.g. Colvin, Witt and Lacey 2016; Spiess et al. 2015; Otto and Leibenath 2014), but also for example extensions of the electricity grid can be problematic (see e.g. Neukirch 2016; Giron 2014). In many jurisdictions, several types of renewable energy projects are subject to EIA, and potential for conflict is often high during the EIA, because it creates an opportunity for stakeholder interactions (Prenzel and Vanclay 2014; Senécal et al. 1999). In some cases, these conflicts stand in the way of implementing projects and plans, contradicting the wish for a transition towards renewable energy.

A previous study indicates that social consequences play an important part in the conflicts (Larsen et al. 2015). Based on this, this paper seeks to illuminate what constitutes the conflicts regarding renewable energy projects. For the purpose of this paper, social impacts are defined in accordance with the international best practice principles on social impact assessment as changes to one or more of the following: People's way of life, their culture, their community, their political systems, their environment, their health and wellbeing, their personal and property rights, and their fears and aspirations. (Vanclay 2003)

Conceptual framework

The conceptual framework for this paper is based on the work of Norwegian sociologist Johan Galtung. He describes conflict as a triadic construction, where contradictions between actors over the issue, attitudes among the actors towards the issue, and behaviour of the actors in the process are equally weighed parts of the understanding of a conflict. Galtung refers to his model as the ABC triangle, where "A stand for attitudes/assumptions, B for behaviour, and C for the contradictions constituting the conflict (Galtung 1998: 3). Galtung describes C as the root of conflict, but also emphasise that as the conflict runs its course, A and B can start taking "ugly shapes". According to Galtung, this can result in A and B constituting the meta conflict, understood as the main conflict or discrepancy, as an overlay conflict after the root conflict. The conflict analysis presented in this paper, is based on this understanding of conflicts. It is also based on the understanding, that conflicts per definition are genuine and present, if just one party perceives them as real. This means, that emotional factors and conditions expressed by citizens, that cannot be backed up with facts, are recognised as subjects of importance for citizens, even if they do not translate into active resistance or articulated opposition.

The conflict analysis is focussed on identifying the conflict, as perceived by affected citizens in local communities subject to planning of new RE-projects. The aim is to explore if conflicts are present and what causes them and to do this, the conflict arena constituted by A, B and C is mapped.

Methodology

This paper is based on a document study of EIA reports for four renewable energy projects and corresponding hearing statements, combined with interviews with citizens impacted by the projects.

The cases investigated in the document study are presented in table 1.

Title	Project type	Year of EIA publication
Sejrø Bugt in-shore wind turbines	In-shore wind turbines	2015
Wind turbines at Ulvemose og Bækhede Plantage	On-shore wind turbines	2015
NGF Nature Energy Månsson A/S	Biogas plant	2014
Photovoltaic power plant at Evetofte	Photovoltaic power plant	2015

Table 1 Overview of RE projects included in the document study

The cases were chosen based on the criteria that they have caused conflict, that the EIA is not older than 2014, and that they represent different types of RE-projects.

For each case an analysis in three steps was carried out:

1. The EIA-reports were reviewed identifying which social impacts are included.
2. Hearing statements were reviewed identifying which social impacts concern the citizens.
3. The two results were compared identifying contradictions between what concerns the citizens and what is included in the EIA report.

The purpose of the interviews was to investigate attitudes towards the project in question, to nuance our understanding of citizens' perception of the projects and the reasoning behind their reactions. Three RE projects were chosen for analysis, as shown in table 2.

Title	Project type	Number of interviews	Time and place
Wind turbines at Ulvemose og Bækhede Plantage (2015)	On-shore wind turbines	3 (6 participants)	22. september 2016, Varde Municipality
NGF Nature Energy Månsson A/S (2014)	Biogas plant	3 (8 participants)	22. september 2016, Brande Municipality
Photovoltaic power plant at Lerchenborg (2014)	Photovoltaic power plant	2 (2 participants)	3. oktober 2016, Kalundborg Municipality

Table 2 Overview of RE project and interviews conducted

Here, the cases were chosen on the basis of the criteria that they are projects with conflict, that the EIA is not older than 2014, that they represent different types of RE-projects, and that they have a manageable size. For each RE project, interviews were arranged with randomly selected residents, living within one kilometre from the facility. Eight interviews were setup, with a total number of sixteen residents participating. The interviews were semi-structured, and the participants were encouraged to tell their story.

Results

Here the results of the analysis are presented following the framework of attitudes, behaviour and contradictions

Attitudes

In terms of attitudes, the hearing statements generally express opposition to the projects**.** Most hearing statements express a wish for relocation of the project. This is especially pronounced in the projects involving wind turbines, where many statements propose to move the turbines offshore. In a number of statements, there is an expression of support for RE generally, despite negative attitudes concerning the specific project. In contrast, many statements question the feasibility of the projects, and weigh the pros and cons of the projects on a overall scale. For example: *We have not heard or read any argument, regarding new jobs, renevue or environmental improvements, that is anywhere close to justify such a severe degradation of nature, environment and quality of life for so many people.* (Hearing statement: Sejerø Bugt in-shore wind turbines, own translation from Danish) The project concerning a photovoltaic power plant at Evetofte stands out among the projects, as relatively many citizens do not express attitudes specifically against the project. They are more focussed on proposing alternatives, for example regarding minor local re-locations or fencing.

Behaviour

In the hearing statements and interviews, issues related to the perceived behaviour of the authorities and proponents in the process and dialogue regarding the RE projects are raised. The issues can be grouped and described as follows:

- Mistrust towards independency of EIA practitioners and content of EIA-reports: The locals point to specific mistakes and incongruences in the EIA-reports, which are considered scrambling the perception of the 'real' impacts. Such issues, together with the fact that the EIA-report is paid for by the proponent, leads to a mistrust of the EIA-report, which is sometimes seen as biased.
- In-transparency in RE-planning processes: Many locals perceive a lack of transparency in the process, for instance in the form of lacking documentation, and limitations when they have requested access to records. Several citizens have also experienced not being informed early on in the process. Several citizens also make the point that it can be difficult to keep up with the development in the projects, for example when changes to the projects are continuously made through the EIA-process.
- Use of limited resources: The citizens also express that they find it very demanding to follow the sometimes year-long planning processes, and that they spend much time and many resources. It is also clear from hearing statements and interviews that some citizens have hired lawyers and draw on external expertise to keep up with the process and write statements. Several citizens point to the how the insecurity for them and their future is a heavy burden through the long processes.
- Allocation of costs and benefits and unequal and inappropriate distribution of compensation: The interviews point to how disagreements about the RE-projects divide the local communities. In many hearing statements and in interviews people point to issues related to compensation, who gets what and why, and how these issues create division and conflict in the local community. Citizens also question whether the compensation is sufficient and whether the right people (most affected) can get compensation.
- Perceived lack of democracy and influence on decision-making: Several citizens perceive that the decision regarding the RE-projects was taken before they were involved, making their opinions insignificant. Also they criticise a perceived lack of response to their enquiries. Citizens to varying degrees criticise the role of the municipalities as not living up to their own stated goals or plans, and siding with the proponent rather than their citizens. Thus the citizens feel that the municipalities place more weight on the short-term economic benefits from the projects rather than protecting their citizens.

The other angle on behaviour is that of the citizens. Here the affected citizens engage to varying

degrees in making hearing statements, talking together in the local community, arranging local meetings, organising local public resistance, seeking access to records, participating in official public meetings, participating in town council meetings, organising petitions, filing complaints to the appeals board, asking the municipality officials questions, participating in field trips to similar facilities, contacting neighbours to similar facilities, talking to local media, meeting with proponent and politicians, contacting industrial actors to pressure the municipality and cooperating with national resistance organisations.

Contradictions

A main part of the conflict, according to the residents, is that their main concerns regarding social issues are not addressed properly during EIA or in the planning processes. They find it unfair that local communities are exposed to negative impacts, because a private proponent is establishing a facility and will make money from it. As one stated in a hearing statement:

…that you can be allowed to put a whole family in that situation. Where we might have to leave our home to sit and rot in a small apartment, and never again be free of debt, while our house rots. All because a private individual choses 'well it suits me to locate it here'. (Interview: NGF Nature Energy Månsson A/S)

Regarding the concerns about social impacts, residents are generally more nuanced, specific and detailed in their concerns than what is captured by the EIA reports. And they generally worry about other impacts, than those addressed in the EIA reports. An overview of the contradictions between the content of the analysed EIA reports, and what is expressed in the related hearing statements and interviews, is presented in Table 3 below. The disagreements, about what is important and should be included in the EIA report and thus the decision making process, are part of the basis for the conflict, in accordance with the conceptual framework.

Conclusion

The results presented in this paper shows what are the main parts of the conflict concerning the analysed RE-projects:

- Attitudes: The attitudes of the citizens are basically that they are against the projects either completely or in their present form and location.
- Behaviour: The perceived behaviour of the authorities and proponents and its repercussions regarding mistrust towards independence of EIA practitioners and -reports, in-transparency in RE-planning, allocation of costs and benefits, use of limited resources, unequal and inappropriate distribution of compensation, lack of democracy and influence.
- Contradictions: There are contradictions between which social impacts concern the citizens and which are dealt with in the EIA-reports, and also in how much detail they are dealt with.

This underpins the assumption that social impacts, and how they are dealt with in the EIA-process, are important to the conflicts concerning RE-projects. It is however an important conclusion, that the citizens emphasise both the contradictions and the behaviour. This means that solely focussing on integrating social impacts in the EIA report - identifying, assessing and mitigating them - will not be enough to respond to the conflicts, a focus is also needed on the process and the dialogue with citizens.

Table 3 Comparative analysis of content in the EIA reports and concerns of the citizens

Social issue	Contradictions	Elaboration and examples
People's way of life	There is a clear contradiction as the EIA reports focus on officially appointed recreational assets, while the statements of citizens express other broader concerns. The statements amongst other address issues, which are more intangible than those assessed in the EIA reports.	For example several citizens mention the use of outdoor spaces around their homes: *Our little paradise is completely shattered. Never again will we be able to sit and enjoy the morning sun in the courtyard.* (Hearing statement: Wind turbines at Ulvemose and Bækhede Plantage)
Culture	No contradiction	Culture is not pronounced as a parameter in either the EIA reports or the hearing statements, and thus is not identified as an issue of contradiction.
Community	There is contradiction, concerning the nuances and understanding of the issues addressed, and the implications of impacts. While the EIA reports generally cover many issues addressed by the citizens, the citizens address a more specific and nuanced perception of potential impacts, which are not covered in the EIA reports.	For example regarding jobs, the citizens are concerned not only about new job opportunities at the facility, which is what the EIA reports mainly include, but about the affect on local development in general, including increased risk of de-population: *We are afraid that the area will loose jobs in the longer term, because these businesses [other local businesses ed.] do not want to create new jobs.* (Hearing statement: NGF Nature Energy Månsson A/S)
Political systems	There is no contradiction in general, though a few citizens point to the issue of non-local management and control of the facility and land passing, which is not being addressed in the EIA reports.	There is in general concordance between statements and content of EIA-reports. The citizens do not express concerns of the RE-project impacting on local democracies.
Environment	No contradiction	There is a large degree of concordance between the concerns of the citizens, and what is covered in the EIA reports.
Health and wellbeing	Concerning the photovoltaic facilities and biogas plant there are no contradictions, as health impacts are not emphasised by citizens or pronounced in the EIA-reports. However, in the cases of wind turbine projects the EIA reports do not satisfactorily cover the issues raised by the citizens, and thus contradictions are present.	The EIA reports for the wind turbine projects, are often focussed on analysing environmental impacts, and whether they comply with limit values. In contrast, the citizens express greater concerns about influences of noise on the level of stress, ability to learn, diabetes and more.
Personal and property rights	There are contradiction related to the EIA-reports narrow focus on impacts on property value and value of agricultural land, while citizens express a broader concern about property values and also raise other issues.	The citizens in all cases express a broader concern about property values, sales period, and the risk of unsalable properties. The citizens also raise issues regarding livelihoods and possibilities to take up loans if negative impacts occur in the community. These issues are not addressed in the EIA reports *If this becomes a reality, we will not be able to live here, but our house is worth nothing. So what do you do? What do we do? We cannot afford to move, but because of the impacts, we cannot live here either.* (Interview: NGF Nature Energy Månsson A/S)
Fears and aspirations	The EIA reports only address issues of road safety, which is in accordance with concerns expressed by citizens. However, the citizens also emphasise issues related to their potential futures, and issues related to cumulative impacts, which are not addressed in the EIA reports.	Citizens refer to impacts on local development and individual economies, as well as to concerns about the future of children and coming generations in the area, and what will be handed down to them. The citizens further emphasise worries about cumulative impacts. They are for example concerned that the projects will lead to development of further industrial facilities, when the area is first considered appropriate for this type of development: *And what is next? Because here in Sejerøbugten nature is no longer pristine, there are wind turbines here. So it has become a place where other infrastructure and plants can be placed.* (Hearing statement: In-shore wind turbines as Sejerø Bugt)

References

Colvin RM, GB Witt and J Lacey. 2016. How wind became a four-letter word: Lessons for community engagement from a wind energy conflict in King Island, Australia. Energy Policy 98: 483-494

Galtung, J. 1998. After Violence: 3R, Recon struction, Reconciliation, Resolution. *Coping With Visible and Invisible Effects of War and Violence. Princeton, NJ: TRANSCEND*.

Giron R. 2014. Struggles on the path to renewable energy: Lessons from SunZia. Natural Resources Journal 54(1): 81-106

Larsen S, A Hansen, I Lyhne, S Aaen, E Ritter and H Nielsen. 2015. Social Impact Assessment in Europe: A Study of Social Impacts in Three Danish Cases. Journal of Environmental Assessment Policy and Management 17(4): 1550038

Neukirch M. 2016. Protests against German electricity grid extension as a new social movement? A journey into the areas of *conflict*. Energy, Sustainability and Society 6(1): 1-15

Otto A and M Leibenath. 2014. The interrelation between collective identities and place concepts in local wine energy conflicts. Local Environment 19(6): 660-676

Prenzel, P. V., & Vanclay, F. 2014. How social impact assessment can contribute to conflict management. Environmental Impact Assessment Review, 45, 30-37.

Senécal P, Goldsmith B, Conover S, Sadler B, Brown K. 1999. Principles of environmental impact assessment best practice. Fargo: International Association for Impact Assesment. Available from: www.iaia.org/publications-resources/downloadable-publications.aspx

Spiess H, E Lobsiger-Kägi, V Carabias-Hütter and A Marcolla. 2015. Future acceptance of wind energy production: Exploring future local acceptance of wind energy production in a Swiss alpine region. Technology Forecasting & Social Change 101: 263-274

Vanclay F. 2003. Social Impact Assessment - International Principles. Special Publication Series. Fargo: International Association for Impact Assessment. Available from: www.iaia.org/publications-resources/downloadable-publications.aspx

Cumulative Effects Assessment of Natural Gas Projects in British Columbia

Anna Vypovska[1], *Laura Johnson*[1], *Dinara Millington*[1], *Allan Fogwill*[1]

[1]Canadian Energy Research Institute, Calgary, AB, Canada, www.ceri.ca
avypovska@ceri.ca

Introduction

The Province of British Columbia (BC) currently is the second largest producer of marketable natural gas amongst the Canadian provinces (CAPP 2016). In 2012, the Province issued a *Natural Gas Strategy* which recognizes natural gas, particularly exports of liquefied natural gas (LNG), as a provincial priority (BC MEM 2012).

Potential cumulative effects from the natural gas development in BC are a growing concern for both stakeholders and the general public. Cumulative impacts are also of particular concerns for Indigenous groups, with many of them unsatisfied with the adequacy of a cumulative effects assessment (CEA) of past, present and reasonably foreseeable industrial activity in their traditional territory, conducted by the proponents, in relation to their respective Aboriginal interests.

This paper examines major cumulative adverse effects to environmental valued components (VCs) and Aboriginal interests arising from development of the natural gas industry in BC, and provides examples of the key approaches to mitigate, manage and monitor these issues effectively.

Methodology

A discussion of existing and proposed natural gas projects within the region is fundamental to the analysis of the current state of this industry in British Columbia. Our study reviewed 18 major natural gas, natural gas liquids (NGLs) and LNG projects in BC that have completed an environmental assessment (EA) process with the provincial and/or the federal responsible authority since January 1, 2010. Distribution by the project type included three natural gas processing facilities, ten natural gas pipelines, one NGL pipeline and four LNG facilities. The proposed projects are representative of the entire geographical region and involve a wide range of output capacities.

For these 18 projects, EA applications by the proponents and, where applicable, EA reports by the provincial regulator (BC Environmental Assessment Office [BC EAO]) and/or the federal regulator (Canadian Environmental Assessment Agency [CEAA] or National Energy Board [NEB]) were reviewed for CEA. In addition, primary regulatory documents and policies issued by the Province of BC were analyzed for cumulative effects initiatives.

Results and Discussion

As required by both the provincial and the federal regulatory bodies, a CEA of natural gas pipeline and LNG projects is to be done for each project and included in the EA application (BC EAO 2015; CEAA 2015). The federal *Canadian Environmental Assessment Act,* 2012 requires that each EA of a designated project takes into account any cumulative environmental effects that are likely to result from the designated project in combination with the environmental effects of other physical activities that have been or will be carried out (CEAA 2015). According to the provincial legislation, if it is expected that a project reviewable under the *BC Environmental Assessment Act*, 2002 will result in any residual adverse effects on the selected VCs, then a CEA for those VCs must be considered. This must be made for all residual adverse effects, not only those predicted to be significant; the significance of any cumulative effects must also be evaluated (BC EAO 2013b, 2015).

A review of the EA reports for the above 18 natural gas pipeline and LNG projects shows that according to the regulators conclusions, the majority of the proposed projects will not likely to result in *significant* cumulative adverse effects to identified VCs taking into account practical means of preventing or reducing to an acceptable level, any potential adverse effects. However, for the wildlife VC, the cumulative effects of past, present and known proposed future projects were rated as significant for three threatened or special concern species (specifically, caribou, grizzly bear and harbour porpoise) on six out of the 18 assessed projects (BC EAO 2013a, 2014a,b,c, 2016b; CEAA 2016).

Certain populations of woodland caribou (*Rangifer tarandus caribou*) in British Columbia are listed as Threatened both federally and provincially; conserving this species is declared a priority for the Government of BC (BC MOE 2016). The decline in woodland caribou numbers in BC may be attributed to loss or alteration of habitat, fragmentation of the herd and increased predation, all resulting from industrial activities (BC MEM 2012). Any additional residual loss of habitat, increase in disturbance of critical habitat, or increase in mortality in the area of the proposed projects will have a serious impact on the potential for recovery of caribou subpopulations. Caribou are likely to alter their movement to avoid noise, activity and disturbance associated with construction activities. A pipeline right-of-way and additional linear development could provide a travel route for predators, while available mitigation to reduce impacts of increased predation is still unproven (BC EAO 2014a,b,c; NEB 2015a,b).

Regarding impacts on caribou, in four of the reviewed projects (Westcoast Connector Gas Transmission, Prince Rupert Gas Transmission, Coastal GasLink Pipeline and Fortune Creek Gas Project), BC EAO concluded that the residual effects of habitat disturbance, sensory disturbance and creation of access from the proposed projects would likely interact with reasonably foreseeable future projects to create cumulative effects. Taking into account the significant project effects and the sensitivity of caribou to further disturbances, the cumulative effects to caribou were considered to be significant (BC EAO 2013a, 2014a,b,c).

Grizzly bear (*Ursus arctos*) is listed as a species of Special Concern under both federal and provincial legislation. Grizzly bears are sensitive to human disturbance, with the cumulative effects of human disturbance being the largest threat to bear populations. In particular, roads are known to have a negative effect on grizzly bear. At the regional scale, open road density higher than 0.6 km/km2 is known to adversely affect habitat use and these effects are magnified when road density increases over approximately 1 km/km2 (Environmental Reporting BC and BC MOE 2012).

Cumulative adverse effects on the grizzly bear population were considered to be significant on one natural gas project out of the 18 reviewed (BC EAO 2016b). The existing average motorized access density within the area that would be intersected by the proposed Eagle Mountain-Woodfibre Gas Pipeline project currently exceeds the minimum threshold for high risk of mortality and displacement for two grizzly bear population units transected by the project. Both units are provincially considered threatened, with core grizzly bear habitat currently remaining well below the recommended minimum target levels, although the habitat loss that would be attributed to the proposed project is negligible. Disturbance from noise created by new and existing roads and linear corridors was found to adversely affect grizzly bear habitat effectiveness, to fragment habitat, to increase mortality risk and to impact the reproductive potential of breeding females. Based on these findings, BC EAO has concluded that while the proposed project alone does not have significant adverse effects to grizzly bears, cumulative effects to this species are considered to be significant (BC EAO 2016b).

Harbour porpoise (*Phocoena phocoena*), federally listed as a species of Special Concern, is highly sensitive to acoustic disturbance (particularly underwater noise), shows strong site fidelity and a higher degree of behavioral response to similar disturbances compared to other marine mammals (CEAA 2016; Department of Fisheries and Oceans [DFO] 2009). The CEAA concluded that the proposed Pacific NorthWest LNG project is likely to result in significant adverse cumulative effects to harbour porpoise, given the number of large industrial projects proposed in the Prince Rupert area that could increase underwater noise and considering that behavioral effects of overlapping projects are expected to occur over a larger area and for a longer period of time (CEAA 2016; MOE 2016).

While British Columbia has less than one-fifth of Canada's Indigenous and First Nations peoples, it is characterized by the greatest diversity of Indigenous population and culture in Canada representing 198 First Nations, or about one third of all First Nations in Canada (INAC 2010). The Province also presents a unique landscape of Aboriginal rights and interests, with the history of treaty making substantially different from the rest of Canada (BC Ministry of Aboriginal Relations and Reconciliation [BC MARR] 2016b).

As stated in the reviewed EA reports, cumulative effects remain a matter of critical importance for various Indigenous groups potentially impacted by proposed natural gas pipeline and LNG projects in the Province. Many of them expressed concerns about the inadequacy of the CEA of past, present and reasonably foreseeable industrial activity in their traditional territory, conducted by the proponents. Specifically, cumulative effects in northeast BC at a regional scale

have been a concern of the Treaty 8 First Nations, including Blueberry River, Saulteau, West Moberly and Fort Nelson First Nations, who are of the view that industrial development in the Western Canadian Sedimentary Basin and northeast BC has already and will continue to result in a reduced ability to exercise their treaty rights. Many Indigenous groups sought a cumulative effects assessment of their territory, relative to their respective Aboriginal interests (NEB 2016).

Throughout its review of the proposed projects, the provincial regulatory authority set out to address Indigenous groups' concerns regarding cumulative effects. BC EAO considered the potential cumulative impacts of multiple proposed natural gas pipeline and LNG projects, along with past, current and reasonably foreseeable future projects, drawing on relevant information provided by the proponents regarding CEA of VCs, as well as the potential impacts of proposed projects on Aboriginal Interests. According to the regulatory authorities, the majority of issues raised during the review processes by Indigenous groups were satisfactorily addressed through existing, revised or new commitments and project design changes made by the proponents, who have made efforts to avoid high value areas for Indigenous groups (for example, by building on existing industrial lands, minimizing clearing wherever possible and providing appropriate mitigation measures to reduce the potential cumulative effects) (BC EAO 2013a, 2014a,b,c, 2016b; CEAA 2016, NEB 2015a,b).

While a high degree of uncertainty regarding the cumulative effects still remains in the region, the Province is moving forward with initiatives that aim to assess and manage cumulative effects to key values, and to consider the impact to Aboriginal rights (BC EAO 2016a). Examples of those initiatives include, but are not limited to, the Cumulative Effects Framework, Area-Based Analysis, Northeast Water Strategy and Water Tool, LNG Environmental Stewardship Initiative, and Regional Strategic Environmental Assessment (BC MARR 2016a; BC MFLNRO and BC MEM 2016; BC OGC 2015a,b; Province of BC 2015, 2016).

Conclusions

This review of the cumulative effects assessment portions of the 18 provincial and federal EAs conducted for natural gas pipeline and LNG projects in British Columbia since 2010 shows that a majority of the EA reports concluded that the proposed projects would not likely result in significant cumulative adverse effects. However, the cumulative effects of past, present and known proposed future projects were rated as significant for three wildlife species VCs (caribou, grizzly bear and harbor porpoise) on a number of the projects assessed. The findings can be mostly attributed to the results of long-term habitat fragmentation and ongoing loss and alteration of the landscape in the region. Growing concerns about the cumulative impacts of natural gas development arising from Indigenous groups potentially affected by proposed projects have also been discussed.

References

BC EAO (2013a), 'Fortune Creek Gas Project Assessment Report', accessed at
http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_379.html

BC EAO (2013b), 'Guideline for the Selection of Valued Components and Assessment of Potential Effects', accessed at http://www.eao.gov.bc.ca/pdf/EAO_Valued_Components_Guideline_2013_09_09.pdf.
BC EAO (2014a), 'Coastal GasLink Pipeline Project Assessment Report', accessed at http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_392.html.
BC EAO (2014b), 'Westcoast Connector Gas Transmission Project Assessment Report', accessed at http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_385.html.
BC EAO (2014c), 'Prince Rupert Gas Transmission Project Assessment Report', accessed at http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_403.html.
BC EAO (2015), 'Environmental Assessment Office User Guide: An Overview of Environmental Assessment in British Columbia', accessed at http://www.eao.gov.bc.ca/pdf/EAO_User_Guide_20150629.pdf.
BC EAO (2016a), 'Northeast British Columbia Expansion Project Assessment Report', accessed at http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_433.html.
BC EAO (2016b), 'Eagle Mountain - Woodfibre Gas Pipeline Project Assessment Report', accessed at http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_406.html.
BC MARR (2016a), 'Liquefied Natural Gas Environmental Stewardship Initiative - Province of British Columbia'.
BC MARR (2016b), 'Treaty 8 First Nations - Province of British Columbia', accessed at http://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/consulting-with-first-nations/first-nations-negotiations/first-nations-a-z-listing/treaty-8-first-nations.
BC MEM (2012), 'British Columbia's Natural Gas Strategy. Fuelling B.C's Economy for the Next Decade and Beyond', accessed at http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-gas-oil/strategy_natural_gas.pdf.
BC MFLNRO, and BC MEM (2016), 'Cumulative Effects Framework - Province of British Columbia'.
BC MOE (British Columbia Ministry of Environment) (n.d.), 'Boreal Caribou Management in BC', accessed at http://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/wildlife/wildlife-conservation/caribou/boreal-caribou.
BC MOE (2011), *Implementation plan for the ongoing management of Boreal Caribou (Rangifer tarandus caribou pop. 14) in British Columbia*. Victoria, BC.
BC MOE (2014), 'Mountain Caribou Recovery in BC', accessed at http://www.env.gov.bc.ca/wld/speciesconservation/mc/.
BC MOE (2016), 'Caribou in British Columbia', accessed 16 October 2016 at http://www.env.gov.bc.ca/wld/speciesconservation/.
BC OGC (2015a), 'NorthEast Water Tool', accessed at https://water.bcogc.ca/newt.
CAPP (2016), *Statistical Handbook for Canada's Upstream Petroleum Industry*, Calgary, Canada.
CEAA (2015), *Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012*, Ottawa, Canada.
CEAA (2016), 'Pacific NorthWest LNG Project Environmental Assessment Report', accessed at http://www.ceaa.gc.ca/050/documents/p80032/115668E.pdf.

DFO (2009), *Management Plan for the Pacific Harbour Porpoise (Phocoena phocoena) in Canada. Species at Risk Act Management Plan Series*, Ottawa, Canada: Fisheries and Oceans Canada.

Environmental Reporting BC, and BC MOE (2012), 'Grizzly Bear Population Status in BC (2012)', accessed at http://www.env.gov.bc.ca/soe/indicators/plants-and-animals/print_ver/2012_Grizzly_Bear_Population_Status_BC.pdf.

Government of BC (2011), 'Interim Operating Practices for Oil and Gas Activities in Identified Boreal Caribou Habitat in British Columbia'.

INAC (2010), 'About British Columbia First Nations', accessed at https://www.aadnc-aandc.gc.ca/eng/.

MOE (2016), 'Decision Statement Issued under Section 54 of the Canadian Environmental Assessment Act, 2012 for the Pacific NorthWest LNG Project', accessed at http://www.ceaa.gc.ca/050/documents/p80032/115669E.pdf.

NEB (2015a), *National Energy Board Report in the Matter of Nova Gas Transmission Ltd. Application Dated 8 November 2013 for the North Montney Mainline Project: GH-001-2014,* Calgary, Alberta: National Energy Board.

NEB (2015b), 'NOVA Gas Transmission Ltd. - Northwest Mainline Expansion - GH-2-2011', accessed at http://www.neb-one.gc.ca/pplctnflng/mjrpp/archive/nrthwstmnlnxpnsn/nrthwstmnlnxpnsn-eng.html.

NEB (2016), *National Energy Board Report in the Matter of NOVA Gas Transmission Ltd. Application Dated 2 September 2015 for the Towerbirch Expansion Project. GH-003-2015,* Calgary, Alberta: National Energy Board.

Province of BC (2015), 'Northeast Water Strategy', accessed at http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/northeast-water-strategy/2015-northeast-water-strategy.pdf.

Province of BC (2016), 'Edition: LNG Environmental Stewardship Initiative', BC Government News, accessed at https://news.gov.bc.ca/newsletters/lng-environmental-stewardship-initiative/lng-environmental-stewardship-initiative/regional-highlights.

Desalination within the water-energy-climate nexus

Annick Walsdorff [(1)], Greg Schreiner[(2)], Claire Davis[(3)], Elsona van Huyssteen[(4)], Thomas Roos[(5)] and Rebecca Garland[(6)]
[(1-6)] Council for Scientific and Industrial Research, PO Box 320, Stellenbosch, 7600

Dr Rolfe Eberhard, Independent professional, 1 Farriers Way, Hout Bay, Cape Town, 7806

[(1)] Corresponding author: awalsdorff@csir.co.za

ABSTRACT

Population growth and increasing urbanisation, deteriorating infrastructure, poor water governance and climate change have the potential to further exacerbate water scarcity in South Africa. As such, the country has become increasingly interested in the potential to utilise large-scale seawater reverse osmosis (SWRO) plants to augment existing water supply options. This particularly applies to growing coastal metropoles such as eThekwini, the City of Cape Town (CoCT) and Nelson Mandela Bay Municipality (NMBM) where water demand increasingly steadily. While SWRO has been touted as a means of alleviating water scarcity, within South Africa's coal dominated energy mix, it is energy intensive and could indirectly account for a significant increase in national greenhouse gas emissions (GHGs). With this in mind, the authors describe some of the background trends accentuating water scarcity in South Africa, how SWRO might be used as an adaptive response measure and some of the key consequences related to GHG emissions from SWRO water production. The analysis concludes that coupling SWRO with renewable energy technologies presents a more sustainable solution to water scarcity that conventional water production sourced from carbon intensive energy sources.

INTRODUCTION

South Africa is water-stressed and already uses existing freshwater resources intensively (DEA, 2013). The poor water endowment makes sound water management and major investment in water infrastructure a necessity for economic growth and poverty reduction. As such, seawater reverse osmosis (SWRO) in growing coastal cities is becoming an increasingly attractive option for water purveyors who have a constitutional mandate to supply potable water of a sufficient volume and quality to the populous. The sparked interest in SWRO is particularly evident in three growing South African metropoles - eThekwini, the City of Cape Town (CoCT) and Nelson Mandela Bay Municipality (NMBM). However, SWRO is energy intensive and South Africa's current energy mix is carbon intensive. It is something of an irony that a water supply technology to increase resilience to climate change would, in turn, contribute to climate change. At the same time, South Africa has an abundance of renewable resources which become increasingly cost-competitive. If large-scale SWRO plants are deployed along growing metropoles in coastal regions, how will these plants contribute to climate change adaptation and the ability to alleviate water scarcity? What will the consequences be for the national GHG emissions inventory? What is the potential to mitigate these consequences through planning for large-scale SWRO by considering renewable energy alternatives?

FACTORS AFFECTING WATER AVAILABILITY IN SOUTH AFRICA

Population growth and water governance

Coastal metropoles play a significant role in South Africa's landscape and economy. In 2013, of the national population, CoCT housed 7% (4 million people), eThekwini 6.6% (3.5 million people) and NMBM just over 2% (1.2 million people) (SACN, 2016; StepSA, 2015). Ethekwini and CoCT showed significant growth over the last few years, due to natural population growth and significant national and international in-migration (SACN, 2016). This has been prompted partly by a national developmental agenda to increase the economic productivity of large ports and expand the national economy around identified port industrial nodes.

Water supplied into the three bulk distribution networks range from 200 to 260 liters per person per day (l/p/d) (see Table 1 – DWS, 2015) versus approximately 100-150 l/p/d in European countries and

400 l/p/d for the United States. Although water is a capital intensive industry requiring a large capital outlay prior to cost recovery, South Africa has developed multi-year water storage capacity and an extensive system of inter-basin transfers to increase resilience to water scarcity. Most infrastructure has been developed, and is managed, by the national Department of Water and Sanitation. These require ongoing maintenance and investment in rehabilitation but have proven reasonably tolerant to underinvestment over protracted periods. Therefore, water utilities in South Africa can decline considerably but still 'function', albeit poorly.

In South Africa, 'non-revenue water'[1] provides a proxy indicator for management efficacy. Table 1 shows non-revenue water, water losses and Infrastructure Leakage Index (ILI) data for CoCT, NMBM and eThekwini. There is some variability between metropoles and performance ranges from average in the case of CoCT; to poor in the case of eThekwini and NMBM.

Table 1: Water management efficiency (DWS, 2015; City of Cape Town, 2016; NMBM, 2006; Moodliar 2015)

Metro	2013-2014					Forecast
	System input volume (Ml per day)	System input volume (l per capita per day)	% NRW	% Water losses	ILI	System input volume (Ml per day)
Cape Town	863 (940 in 2015)	196	21.1	13.9	2.3	1 480 in 2035
eThekwini	912	257	39.4	38.2	6.8	1 455(*) in 2035
Nelson Mandela Bay	295	244	42.3	40.3	6.2	450 in 2025

(*) Given a 0.5% water loss reduction from 2016/2017

A recent review of water infrastructure serving South Africa's cities, undertaken for National Treasury in 2016, concluded that "*there is increasing evidence that the water reticulation network (through which water is distributed to customers) is becoming less reliable, resulting in more frequent and more severe unplanned water disruptions in many of South Africa's cities and towns*." This suggests that while climate change and increasing population growth will play a significant role in accentuating water scarcity in South Africa, the 'root' cause of shortage of supply must be attributed to poor governance and lack of effective leadership (Auditor-General, MFMA 2014-15 consolidated general report on audited outcomes).

Climate change

Rainfall projections show a general drying pattern over South Africa, in particular in the south-west where the duration of dry spells is expected to increase (Engelbrecht *et al.*, 2013). An increase in the frequency of both heavy and extreme rainfall events is likely over the eastern parts of the country during the summer months (Figure 1).

[1] Non-revenue water refers to all the water that is lost through physical leakage or commercial losses (meter under-registration, billing errors, theft etc.) as well as any unbilled authorised consumption (fire-fighting, mains flushing etc.).

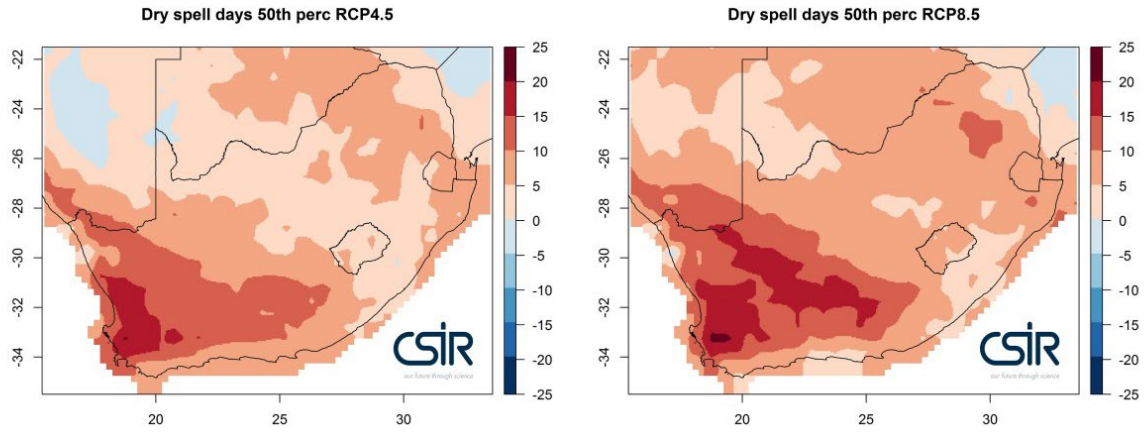


Figure 1: Projected changes in rainfall for South Africa measured as the number of dry spell days.[2]

SEAWATER REVERSE OSMOSIS

Global installed desalination capacity in 2016 was 88 900 Ml/day, the majority comprising one of three technologies: reverse osmosis (RO) (67.1% of which 53 429 Ml/day is dedicated to SWRO), multi-stage flash (19%) and multi-effect distillation (7.2%) (IDA, 2017). Given improvements in RO energy efficiencies, preference is now afforded to SWRO whose energy consumption, while salinity dependent, ranges from 3.5kWh/m^3 (39 000ppm) to 4.25kWh/m^3 (46 000ppm) including pre-treatment. This is lower than multi-stage flash and multi-effect distillation which range from 4.7 to 7.3kWh/m^3 of potable water (Fichtner, 2011).

The largest SWRO plant commissioned to date is the 540Ml/day Soreq SWRO plant in Israel. A number of small-scale RO plants have been installed in South Africa. Feasibility studies for larger scale SWRO plants (150 to 450Ml/day) are underway for Cape Town and Durban. Table 3 shows average values for capital expenditure (CAPEX), operational and maintenance costs and the cost of water production for desalination plants in the MENA region[3] as well as projected costs for a 150Ml/day SWRO plant in South Africa.

Table 3: Summary of average desalination costs in MENA[3] Region (after ALMAR, 2016)

Desalination Plant Type	CAPEX (Million US$/MLD)	Operational and Maintenance (O&M) Cost (US$/m^3)	Cost of Water Production (US$/m^3)
SWRO Mediterranean Sea	1.2	0.35	0.98
SWRO Arabian Gulf	1.5	0.64	1.35
SWRO Red Sea	1.5	0.51	1.38
Hybrid SWRO	1.3	0.35	1.03
MSF	2.1	0.26	1.44
MED-TVC	1.4	0.14	1.39
Hybrid MSF/MED	1.8	0.23	1.15

Note 1: Projections for a 150ML/day SWRO in eThekwini, South Africa show that CAPEX would range roughly between 2.0 to 2.2 Million US$/MLD, the cost of water production is estimated at about 1.03 US$/m^3 and O&M: 0.6 US$/m^3 in 2027 when the plant would be at full production.

[2] Based on Representative Concentration Pathways (RCPs), RCP 8.5 and RCP 4.5, which assume different paths of development for the world. RCP 4.5 describes a future with relatively ambitious emission reductions and RCP 8.5 with no reductions in emissions (Meinshausen et al., 2011).

[3] Middle East and North Africa

COUPLING SWRO WITH RENEWABLE ENERGY

While South Africa's energy mix is still overwhelmingly dominated by domestic coal, the country has committed to developing 55 GW of renewable energy (wind and solar photovoltaic sources) by 2050 (DoE, 2016). The annual solar resource for CoCT, NMBM and eThekwini are 1900-1950kWh/m^2, 1700-1750kWh/m^2 and 1550-1700kWh/m^2 respectively.

Assuming a case-study of a 300Ml/day large-scale SWRO plant located in or near Cape Town. Based on a ratio of 1ha solar field per Ml (after ALMAR, 2016), this would require approximately a 300 ha solar field, corresponding roughly to a 150 MW solar PV farm.

Assuming 1.42 L of freshwater is used at coal-fired power stations in the production of 1 kWh electricity and approximately 1.03kg of CO_2 will be emitted to the atmosphere (ESKOM, 2012), equating to approximately 1.07kg CO_2-equivalents[4] (CO_2eq) (Latterman, 2010) and based on an estimation of 0.11kg CO_2eq/kWh by a photovoltaic solar plant (Baldwin, 2017), coupling a large scale SWRO plant with supply from a solar farm would lead to carbon savings of 1 007 tons of CO_2eq per day. This constitutes 0.09% of South Africa's greenhouse gas emission reduction policy of 428 Mtpa CO_2eq by 2050 (RSA, 2011).

The REIPPPP solar photovoltaic electricity price was probably determined for sites with near-ideal annual solar resource levels of ≥2 000 kWh/m^2. Based on the solar resources in the vicinity of the CoCT, this suggests that large-scale photovoltaic plants built for SWRO may generate electricity at costs, in the order of, of ZAR 0.64/kWh.

For Cape Town, electricity costs have been calculated at approximately 64 ZARc/kWh for solar power (= ZAR 2.24/m^3 potable water) and range from ZAR 1.07 to ZAR 1.14/kWh for municipal electricity during standard demand (=ZAR3.75 to ZAR 5/m^3 potable water). Supplying a SWRO plant in Cape Town with solar energy would therefore lead to roughly a 41 to 44% electricity cost savings, which can be translated to roughly 20% O&M costs savings (given that electrical energy makes up for approximately 51% of O&M costs). To guarantee a reliable production of potable water, it is however still recommended to have the municipal grid as a back-up for when supply is insufficient and as a customer of excess electricity generated on good days.

DISCUSSION

South Africa is facing significant challenges to matching increasing water demand with limited supply options, reduced water quality and inefficient use of existing infrastructure and resources.

It seems evident that significant attention should be paid to the reduction of water losses from poorly maintained infrastructure and further implementation of water conservation and water demand management strategies, including the re-use of water particularly in coastal cities where wastewater is lost to sea via marine outfall. A reduction of water losses requires better asset management and maintenance/refurbishment of infrastructure by all institutions in the country as well as an improvement in effective leadership and governance in affected municipalities (Auditor-General, MFMA 2014-15 consolidated general report on audited outcomes).

There is an increasing interest in SWRO as an option to alleviate water scarcity. This trend is intensified by the impacts of climate change on available surface- and groundwater resources. In this respect, the South African National Water Resource Strategy 2 (DEA, 2013) and the National Desalination Strategy (DWS, 2011) both envision the use of SWRO in coastal regions of the country as a long-term strategy to respond to an increasing water demand.

Climate change mitigation takes preventive actions through reduction of GHG emissions, while climate change adaptation is generally an iterative process of avoiding harm and exploiting opportunities (Field et al., 2014). SWRO can be seen as an adaptation option, as it strives to augment

[4] CO_2eq is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential.

existing water supplies that may be vulnerable to a changing climate. However SWRO is energy intensive and thus with a majority of South Africa's energy coming from coal, is also emissions intensive (DEA, 2016). Without use of low-emission energy sources such as renewable energy sources, an increased use of SWRO with the current energy mix would increase GHG emissions and contribute negatively to climate change mitigation efforts.

The extent to which energy requirements are likely to place constraints on the adoption of SWRO plants in line with national commitments to carbon emission reduction is to be considered. Cape Town, Port Elizabeth and Durban are known for suitable solar and wind energy. The coupling of SWRO desalination plants with renewable energy in the studied coastal cities and the continuous improvement in energy efficiency of desalination technologies therefore has the potential of providing a sustainable and environmental friendly source of potable water. Additionally, where there is sufficient waste heat available, desalination technologies such as multi-effect distillation, may also be considered, for example, adjacent to a nuclear power station facility or a refinery, as it is the case for Cape Town and Durban respectively.

Although resources are not an absolute constraint, South Africa's low economic growth and high indebtedness constrain the availability of government grants and more reliance will need to be placed on commercial finance to support investments in urban water infrastructure. Urban water projects lend themselves to project finance and a desalination plant serving a city could be financed this way.

REFERENCES

ALMAR, 2016. Desalination Technologies and Economics: CAPEX,OPEX & Technological Game Changers to Come. Mediterranean Regional Technical Meeting, December 12-14. Marseille.

Baldwin, S., 2017. Carbon footprint of electricity generation. Retrieved February 08, 2017, from http://www.geni.org.

City of Cape Town, 2016. City of Cape Town Medium Term Infrastructure Investment Framework 2016/2017 – 2017/2018. Unpublished report.

DEA, 2016, South Africa National Adaptation Strategy (Draft for comments).

DEA, 2013. National Water Resource Strategy, Second Edition.

DoE, 2013. Integrated Resource Plan for electricity (IRP) 2010 - 2030: Update Report.

DoE, 2016. Integrated Resource Plan Update: Assumptions, Base case and observations, Rev1, Draft.

DWS, 2015. A Water Balance Assessment of South Africa's Metropolitan Municipalities.

DWS, 2011. National desalination strategy.

Engelbrecht, C., Engelbrecht, F., Dyson, L., 2013. High resolution model projected changes in mid tropospheric closed lows and extreme rainfall events over southern Africa. International Journal of Climatology 33, 173-187.

Eskom, 2012. Annual Integrated Report.

Field et al., 2014. Technical summary. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability [Field, C.B., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 35-94.

Fichtner, 2011. MENA Regional Water Outlook Part II: Desalination Using Renewable Energy Task 1 – Desalination Potential. Stuttgart.

IDA, 2017. IDA Desalination Yearbook 2016-2017. Retrieved from http://idadesal.org.

Latterman S., 2010. Development of an EIA and decision support system for seawater desalination plants.

Meinshausen, M., Smith, S.J., Calvin, K., Daniel, J.S., Kainuma, M., Lamarque, J., Matsumoto, K., Montzka, S., Raper, S., Riahi, K., 2011. The RCP greenhouse gas concentrations and their extensions from 1765 to 2300. Climatic Change 109, 213-241.

Moodliar, S, 2015. Ethekwini Municipality Planning of Water and Sanitation. Presentation at the Miles Master Class. Accessed on 25 January 2017at http://www.mile.org.za.

Nelson Mandela Bay Metropolitan Municipality, 2006. Water Master Plan 2005-2020. Unpublished Report. Accessed at http://www.nelsonmandelabay.gov.za/datarepository/documents/water-master-plan-2005-2020.pdf on 1 February 2017.

RSA, 2011. The Government of the Republic of South Africa, National Climate Change Response White Paper, Pretoria, October 2011.

SACN (South African Cities Network), 2016. State of South African Cities Report, 2016.

StepSA, 2015. Town growth profiler, based on SACN/CSIR Settlement Typology and CSIR Mesoframe Socio-Economic Indicators 2014. https://docs.google.com/spreadsheets/d/1P6vQCLvk5HZKHdDHLu55NGT5jA2fyjxUliec035Vnp8/pubchart?oid=550799582&format=interactive.

Re-examining knowledge production in EIA

Jean Welstead

Abstract

An Environmental Impact Assessment (EIA) is a process that systematically produces knowledge about a proposed project to inform decision makers and the public. It aims to provide an objective account of the project's impacts, mainly based on science-based methodologies, to assess the nature and extent of changes to the baseline characteristics of the study area and offer measures to mitigate any significant negative impacts. However, how this knowledge is constructed, its underlying epistemological assumptions and its role in the outcomes of the assessment and possible social responses are seldom discussed. This paper will explore how different types of knowledge can be valued in the EIA process, especially as the new sphere of climate change is incorporated. Drawing on the work of Cashmore (2004) and Callison (2014), it will discuss how the way an EIA process is modeled may lean towards scientific analysis at the expense of stakeholder input and how climate change 'facts' can have different meanings to different actors.

Research context

This paper has been developed from the early stages of PhD study that will examine how the way in which impact assessment is conducted in Scotland might influence the social responses to a proposed renewable energy (RE) project. RE deployment is seen as crucial to mitigating climate change by reducing carbon emissions. However, its scientific basis is sometimes questioned and can lead to the benefits of RE deployment being undermined. Worldwide RE deployment as a form of energy diversification is viewed as a central task, yet public opposition may slow down this process (Batel et al., 2013). Onshore windfarm EIAs, for example, raise a complex set of issues including 'landscape aesthetics, community (dis)empowerment and the relative importance of global and local factors', and there is a need to 'deepen our understanding of the social construction of public attitudes' to such projects (Warren and Birnie 2009:97). Drawing on sociology of science literature this research will examine the ways in which impact assessment is done, in particular, socio-economic impact assessment (SEIA), and how these differences might matter and influence the social responses to a proposed RE project. Such examination of SEIA and climate impacts assessment may enable the development of a more theory driven impact assessment practice.

The construction of knowledge and meaning in EIA

The EIA involves the production of knowledge and meaning in the form of supporting evidence as an 'aid to decision-making' (Glasson et al., 2012:7). The content of the EIA Report is based on the collective knowledge generated and constructed by actors involved in the project (Burr, 2015), for example, contributions from EIA technical disciplines, the developer, consultees and stakeholders. This knowledge then provides a vehicle by which to 'broker' a

decision concerning the planning consent for that project (Partidario and Sheate, 2013). This process has been replicated and developed since the origins of EIA in the 1969 National Environmental Policy Act (USA). However, it has been contended that since its inception, and partly due to rapid replication, there has been insufficient attention given to the assessment theory behind EIA practice (Becker and Vanclay, 2003; Cashmore, 2004) and that it remains anchored to a period when positivism and rationalism in the sciences predominated (Ross and Lane, 2001).

Cashmore's (2004) work explores the underlying philosophical assumptions of EIA practice. He considers the role, type and form of science involved in EIA and how this relates to decision-making. Cashmore contends that although EIA procedures and practice have developed considerably, the exact purpose of EIA and the theory underpinning the role of science within it has meant that an appropriate scientific model has not been established. This is important, as Cashmore argues, because without a comprehensive definition it is not possible to develop a detailed and complex understanding of the causal processes involved to achieve the purposes of EIA. In turn this may compromise the knowledge produced by the assessment for example, due to the type of questions asked, and the information and participants accepted in environmental decision-making (Hajer and Wagenaar, 2003). This raises questions for this research, for example, could it be that the EIA process and report influences social responses to the proposed project not just by its contents and conclusions but also through the philosophical arguments embedded within the knowledge construction process. Indeed, the extent to which members of the public are aware of and engaged in these processes may also be helpful in discussing how these processes influence social responses.

To examine this further and to explore the implications of incorporating climate change into the EIA process it is useful to consider the knowledge production process from a sociological perspective.

EIA as scientific practice

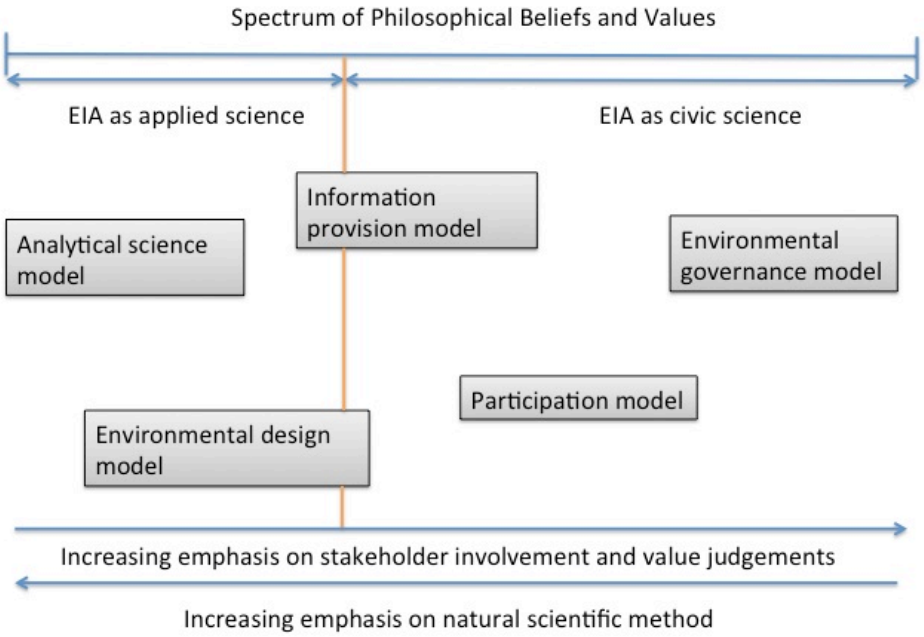
The origins of EIA legislation and its focus on the 'natural' environment has led to a predominance of applied natural science and engineering based disciplines being involved in its knowledge production. Applied science uses existing knowledge to understand practical applications, whereas pure science yields theories and predictions, as in natural sciences such as chemistry, biology, geology and physics. Those that study the role of science in society contend that in the western world science has been given special status as the reliable way to produce knowledge and understand how the world operates (Yearley, 2005). Inherent in this special status has been a demarcation between science and non-science which argued Gieryn (1983) helped scientists acquire and maintain intellectual authority.

The EIA Report is generally based on 'objective scientific facts' (Cashmore, 2004: 414) without acknowledging the inherent scientific values used in support of its

'rational' argument (Kuhn, 1977, Newton-Smith, 1981, Yearley, 2005). It may also be that by creating an artificial boundary between science and non-science that the knowledge that might be generated by other social actors or stakeholders is largely excluded. For example, the uncertain status and in some cases active exclusion of disciplines such as SEIA, which is seen by some as too value-driven and as having the potential to compromise the scientific findings of the EIA (Chadwick, 2002). Indeed, as Gieryn explains these boundaries are ambiguous and flexible, representing ideologies rather than science as 'distinctively, truthful, useful, objective or rational' (Gieryn, 1983:792). Thus it may be that the knowledge production process for EIA should be viewed as presenting a set of ideologies, of its time and place, rather than an objective and independent impact assessment. This research will examine the role of science in EIA practice and what impact this might have on other types of knowledge that might be generated by the participation of non-experts.

If, as required (2003/35/EC), EIA is to actively involve the public in environmental decision-making it would seem important for those engaging with the assessment process to understand how this knowledge is constructed and the assumptions therein. This would call for a more reflexive approach to science (Jasonoff, 2004) and the underpinning but competing scientific theories of EIA design to be made explicit as demonstrated by Cashmore's study (2004). In turn such a classification of EIA models can identify not only the role of science but also how it relates to the level of public participation within EIA. For example, Cashmore argues that close alliance to the ideas of logical positivists at his 'Applied Science' end of the spectrum (see Figure 1) may not only define the role of science within EIA but also constrain the purposes of the EIA by imposing the epistemological beliefs of science upon it. In contrast a constructionism perspective includes models under an increasingly 'civic science' approach representing a closer interaction between science, expert knowledge and the public in a more democratic planning process. For example, in his 'Analytical Science Model' there is strict separation of facts and values whereas in his Environmental Governance Model (EMG) there is an extensive role for social sciences, a limited role for natural sciences and a strong emphasis on social values and the recognition of information as a social construct.

Figure 1. Conceptions of the role of science in EIA



Source: adapted from Cashmore, 2004: 407

Cashmore (2004) contends that good scientific practice is still a core principle in these models but that the civic science models strike a balance between art and science. Critically the EMG model appreciates the political and social nature of policy and decision-making and, like all political processes, EIA 'becomes a framework for negotiation and compromise' (Ibid: 413).

Climate change, climate impacts and EIA

In EIAs for RE projects, especially windfarms, a discussion of the benefits of the proposed project in terms of climate change has, since the outset, (e.g. National Wind Power Ltd, 1992) been used as a method of framing the knowledge produced for the EIA Report with the intention of mobilizing people to accept projects (Johnston and Noakes 2005). This was demonstrated by Corvellec and Risberg (2007: 309) in their examination of how Swedish windfarm developers manage the planning consent process through meaning management by: 'contextualising the project' using co-texts such as legislation or climate change; 'ontologising its characteristics' making it seem real, through images, maps and carbon savings; and 'neutralizing any criticism' by producing knowledge that is difficult to refute. The new requirements (2014/52/EU), however, do bring some additional aspects to this assessment. Firstly, the assessment of potential climate change impacts upon the project introduces a stronger emphasis on risk assessment with the implication that this can be 'measured and weighed objectively' (Yearley, 2005:129). Secondly, the advice that carbon impacts should

be assessed using 'available environmental information and scientific knowledge' (2014/52/EU) is likely to introduce more computer modeling of impacts into the knowledge production process even though this may raise 'new obstacles to public understanding and participation' (Yearley, 1999:845).

Of interest to this research is whether the scientific rationale behind the climate impacts assessment may emphasise the applied science and over the civic-science paradigms of Cashmore's models and thus de-emphasise the role of public participation or whether there is empirical evidence to the contrary such as the use of multi-criteria decision analysis. However, climate change is complex, as Callison (2014) demonstrates in her work exploring how climate change comes to matter to American publics. For example, she found that 'facts' about climate science tend to be transformed into different meanings depending on the 'interpretative frameworks and epistemologies' (Ibid.:199) through which they are negotiated. For example, Inuit people have resisted "climate change" discourse despite being held up as an example of where unsustainable impacts are being felt and local observation of many symptomatic changes. Callison found that such changes are more likely to be negotiated through Traditional Knowledge and a human rights framework than sustainable development or environmental protection (Ibid.).

In terms of EIA knowledge production, advocating climate science as the 'truth' can be problematic as it conflicts with the professional norms of continual scrutiny and the inherent incompleteness of scientific knowledge (Callison, 2014). It has also been argued that climate change should be viewed as an intellectual resource around which identities and projects can take shape (Hulme, 2009) rather than scientific fact. Indeed, the public may raise questions about the 'supposed impartial methods of science used to diagnose the globe's (climate) problems' (Yearley, 2005:167). In light of previous discussions in this paper climate impacts assessment appears to resonate with the suggestion that science presents ideologies rather than truths (Gieryn, 1983) and that EIA provides a knowledge production framework within which to negotiate these ideologies (Cashmore, 2014).

Conclusions

This initial exploration of the epistemological assumptions within EIA knowledge production indicates the importance of understanding the potential role of applied and civic-science paradigms in relation to public participation and the social responses to a proposed project. As part of this PhD these ideas will be developed further through a critique of extant SEIAs using epistemological models, such as Cashmore's, to explore whether a more reflexive approach to SEIA influences participation levels and social responses, with the potential to advance EIA theory and practice.

References

Batel, Susana, Devine-Wright, Patrick and Tangeland, Torvald. (2013) 'Social acceptance of low carbon energy and associated infrastructures: A critical discussion.' *Energy Policy* 58 1-5

Becker, H and Vanclay, F. (2003) *The International Handbook of Social Impact Assessment. Conceptual and Methodological Advances*. Cheltenham (UK) and Northampton (USA), Edward Elgar.

Burr, V. (2015) *Social Constructionism*. Third edition. Hove, East Sussex; New York, NY: Routledge.

Callison, C (2014) *How Climate change comes to matter: the communal life of facts.* Durham, NC and London: Duke University Press.

Cashmore, Matthew. (2004) The role of science in environmental impact assessment: process and procedure versus purpose in the development of theory. *Environmental Impact Assessment Review* 24 403–426.

Chadwick, A. (2002) Socio-economic Impacts: Are They Still the Poor Relations in UK Environmental Statements?, *Journal of Environmental Planning and Management*, 45:1, 3-24.

Corvellec, H, and A. Risberg (2007) Sensegiving as mise-en-sens – The case of wind power development. *Scandinavian Journal of Management*, 23, 306-26.

European Union (2003) *Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC.*

European Union (2014) *Directive 2014/52/EU amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.*

Gieryn, T.F. (1983) Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists.' *American Sociological Review*, Vol. 48, No. 6 (Dec., 1983). Pp/781-795.

Glasson, J., Therivel, R. and Chadwick, A. (2012) *Introduction to Environmental Impact Assessment.* 4th edition. Routledge.

Hajer M, Wagenaar H. Introduction. In: Hajer M, Wagenaar H, editors. (2003) *Deliberative policy analysis: understanding governance in the network society.* Cambridge: Cambridge Univ. Press; p. 1–30.

Hulme, M. (2009). *Why We Disagree about Climate Change: Understanding Controversy, Inaction, and Opportunity*. Cambridge: Cambridge University Press.

Jasonoff, S., (2004) *Design on Nature: Science and Democracy in Europe and the United States.* Princeton: Princeton University Press.

Johnston, H, Noakes, J (2005) *Frames of Protest: Social Movements and the Framing Perspective.* The Rowman and Littlefield Publishing Group, Maryland, USA.

Kuhn, Thomas, S. (1977) *The Essential Tension: Selected Studies in Scientific Tradition and Change.* Chicago: University of Chicago Press.

National Windpower Ltd. (1992) *Trysglwyn Windfarm Environmental Statement*. Machynlleth, Wales: Dulas Engineering Ltd.

Newton-Smith, William H. (1981) *The Rationality of Science*. London: Rouledge and Kegan Paul.

Partidario, M.R. and Sheate, W.R. (2013) Knowledge brokerage - potential for increased capacities and shared power in impact assessment. *Environmental Impact Assessment Review.* Volume 39, February, pp. 26–36

Ross, H and Lane, M. in Dale, A, Taylor, N, Lane, M, editors (2001) *Social Assessment in Natural Resource Management Institutions. "Social Impact Assessment and Resource management at the Australian federal Level: Trapped in an epistemological corner."* CSIRO Publishing, Queensland, Australia.

Warren, C. and Birnie, R.(2009) 'Re-powering Scotland: Wind Farms and the 'Energy or Environment?' Debate' *Scottish Geographical Journal.* Vol. 125. No. 2, June, pp. 97-126.

Yearley, S., (1999) Computer Models and the Public's Understanding of Science: A Case-Study Analysis. *Social Studies of Science*, Vol. 29, No. 6 (Dec., 1999), pp. 845-866. Sage Publications Ltd.

Yearley, S., (2005) *Making Sense of Science: understanding the social study of science.* Fifth edition. California: Sage.

Comparison of social costs of underground and open-cast coal mining

Galina Williams (g.williams@cqu.edu.au)
Senior Lecturer in Economics
School of Business and Law, CQUniversity, Australia

Abstract

This paper presents a methodology for assessment of socio-economic costs from underground and open-cast coal mining. It can be used for comparison of social costs of specific coal mining projects.

1. Introduction

While coal mining might contribute significantly to a country's export and GDP, it has a lesser impact on national employment and income. On the other hand, mining can create several adverse environmental impacts including air, water and soil pollution, deforestation, negatively affect wildlife and contribute to some socio-economic problems such as community displacement, housing pressures, ill-health and child labour.

The total cost of mining includes the direct mining cost and social cost. The social costs include the impacts to the environment and socio-economic systems. According to the estimates for the complete costs of coal, coal mining only accounts for 22% of total social (external or "hidden") costs of coal (Epstein, Buonocore et al., 2011). The rest is attributed to the coal transportation, coal combustion, waste disposal, electricity transmission and climate change.

Social costs of mining vary substantially in both underground (UG) and open cast (OC) mining, depending on many factors such as the geological position of the deposits, the technology used, the characteristics of overburden, the scale of the mining, the proximity of the villages and townships. In general, OC mining is considered to be safer and more productive but having a higher environmental impacts than UG mining (World Bank 1998; Sahu, Prakash et al. 2015).

The valuation of social costs can be accomplished using different market and non-market valuation techniques (Ivanova, Rolfe et al. 2007, Ivanova and Rolfe 2011, Ivanova 2014). However, it can be hard to assign economic values to all socio-economic impacts from UG and OC mining. This paper provides a methodology for comparison of the social and economic costs of UG and OC mining.

Section 2 of this paper presents an overview of some potential impacts of coal mining on environmental, social and economic systems focusing on UG and OC mining. Section 3 compares the UG and OC mining impacts using arbitrary values. Section 4 provides summary and conclusion.

2. UG and OC coal mining: impacts

The impacts of mining are numerous. They include changes to physical environment, such as landslide and land subsidence, soil erosion, changes in existing topography and visual impacts of an open pit or waste dump. In addition to removing vegetation and changing the existing topography, OC mining produces large amounts of solid waste.

Altun et al. (2010) stated that the main physical impacts of UG mining are subsidence and slope deformation which in turn affect ground and surface water, land surface (including buildings, services and communications). Malgot and Baliak (2004) suggested that the impact of subsidence can extend beyond than the mining area.

Mining can change the quantity of surface and underground water and affect its quality. Acid mine drainage (AMD) or acid rock drainage (ARD) can be generated by discard dumps including those rehabilitated. The outflow of acidic water can happen 5 to 20 years after closure (Munnik, Hochmann et al. 2010). ADM can result in the deterioration of the water quality, health issues, damaged flora and fauna.

The noise and vibration from blasting can damage houses, other buildings and infrastructure. It can affect people and wildlife (Epstein, Buonocore et al. 2011, Dukka, Mahatha et al. 2004).

Mining can change the diversity of productivity of vegetation, impact on rare or endangered species, impact animal or fish population and present a barrier to the animal migration (Dukka, Mahatha et al. 2004).

Coal mine fires can occur in both UG and OC mines. They can be caused by lightening, forest fires, mine subsidence, the burning of trash, and electrical sparks from equipment (Sisodia 2013). Coal mine fires have serious social, ecological, and economic impacts. For example, the Centralia fire in Pennsylvania cost over $30 million, with most of the costs going toward relocation of residents (PADEP 2008, PADEP 1996).

The change to physical environment affect the land use. It is likely that the activity such as farming that was performed before OC mining took place can no longer be carried out. That include cessation of farming, tourism, reliance on the forest/nature for hunting/food and water supply.

The health and safety impacts of coal mining at workplace are significant. There are potential health hazards; risk of accidents from explosion, release of oil, radioactive materials, toxic substances (Dukka, Mahatha et al. 2004). Generally, the number of accidents and fatalities in the UG mines are higher than in OC mining (Mintz 1976, Joyce 1998, Harris, Kirsch et al. 2014).

Mining can have a positive effect on the local economy in terms of providing employment and income to the workers. However, the impact on local economy might be overstated as Fernandes (2007) noted that most mining jobs went to outsiders since the local population (predominantly tribal)

lacked the required skills. Furthermore, the presence of a coal mine does not necessarily translates into the increase in income level in the community. Epstein et al. (2011) argued that in Appalachia, as the levels of mining increased, so did the poverty rates and unemployment rates. They stated that at the same time educational attainment and household income levels declined.

Mining induced displacement and resettlement is higher at OC mines. For example, in India these phenomena increased substantially since the 1970s as the country's coal production shifted from UG to OC mining, increasing the negative impacts on communities such as joblessness, homelessness, marginalization, food insecurity, loss of common lands and resources, increased health risks, social disarticulation, the disruption of formal educational activities, and the loss of civil and human rights (Downing 2002).

Since some of the negative impacts from coal mining are not paid for by the coal mining companies, UG and OC coal mining creates a burden on a local, state or national government in the form of additional costs of healthcare, water treatment, reclamation (if not reclaimed or partially reclaimed by mining company), welfare support due to unaffordable housing.

3. Comparison of UG and OC mining impacts

Using GHD (2013) social impact risk matrix, the following classification of social and environmental consequences of UG and OC mines is used to compare the impacts.

Table 1. Social impact risk matrix (GHD 2013).

Likelihood	Consequence (at current practice)				
	Catastrophic	Major	Moderate	Minor	Insignificant
Almost certain (>=95%)	Extreme	Extreme	High	Medium	Medium
Likely (50-95%)	Extreme	Extreme	High	Medium	Medium
Possible (20-50%)	High	High	Medium	Medium	Low
Unlikely (5-20%)	High	Medium	Medium	Low	Low
Rare (<5%)	Medium	Medium	Medium	Low	Low

Table 2 presents the likelihood and the consequences of the UG and OC mining impacts, the impacts significance and the nature of the impacts based on GHD (2013) classifications and literature review.

The following numbers were assigned to the consequences of social impacts: extreme=4, high=3, moderate=2 and low=1. If the impacts are negative, then the sign of the consequences of impacts are negative, if the impacts are positive, then the sign of the consequences of impacts are positive, if the impacts are neutral, then the impacts are multiplied by zero. By applying this scoring convention to the criteria presenting it Table 2, the negative impacts of mining are -47 for the OC mining and -40 for the UG mining. That means that the social costs of OC mining (given the scenarios) are 15% more than the social costs of UG mining. It should be noted that the impacts and their consequences are not weighted. That means that the environmental damage is assumed to be equal in importance to the human displacement or fatalities. However, depending on how weights are assigned the results of the

analysis will likely change. For example, if higher weightings are applied to workplace safety and damage from AMD, then the social cost of UG mining would be higher than from the OC mining. It should be pointed out that some impacts in table 2 are overlapping (e.g. water quality and healthcare), therefore a care needs to be taken to separate those impacts for each individual project.

This method allows to compare the social costs from UG and OC mining from proposed projects during the impact assessment stage of approval process. The next step is to collect data for economic evaluation methods for the full socio-economic impact assessment of the proposed projects.

Table 2. Comparison of impacts significants[1] of hypothetical UG and OC mines.

Impact	Open-cast (OC)				Underground (UG)			
	Likelihood	Consequence	Impact significance	Nature of the impact	Likelihood	Consequence	Impact significance	Nature of the impact
Topography; visual; soil erosion	Almost certain	Catastrophic	Extreme	Negative	Likely	Catastrophic	Extreme	Negative
Landslide and subsidence	Rare	Minor	Low	Negative	Likely	Major	Extreme	Negative
Solid waste	Possible	Minor	Medium	Negative	Unlikely	Minor	Low	Negative
Surface water	Almost certain	Catastrophic	Extreme	Negative	Unlikely	Catastrophic	High	Negative
Groundwater	Likely	Major	Extreme	Negative	Possible	Major	High	Negative
Noise and vibration	Likely	Moderate	High	Negative	Unlikely	Moderate	Medium	Negative
Biological flora/fauna	Almost certain	Catastrophic	Extreme	Negative	Possible	Moderate	Medium	Negative
Air pollution (methane)	Almost certain	Major	Extreme	Negative	Almost certain	Major	Extreme	Negative
Acid water drainage	Possible	Major	High	Negative	Possible	Major	High	Negative
Coal mine fires	Possible	Major	High	Negative	Possible	Major	High	Negative
Land use (e.g. farming, fishing)	Almost certain	Catastrophic	Extreme	Negative	Unlikely	Catastrophic	High	Negative
Recreation, Aesthetics	Almost certain	Catastrophic	Extreme	Negative	Possible	Insignificant	Low	Negative
Workplace health and safety	Unlikely	Major	Medium	Negative	Likely	Catastrophic	Extreme	Negative
Employment, income	Almost certain	Moderate	High	Positive	Almost certain	Moderate	High	Positive
Healthcare	Likely	Moderate	High	Negative	Unlikely	Minor	Low	Negative
Society	Possible	Minor	Medium	Negative	Possible	Minor	Medium	Negative
Cultural, displacement	Possible	Major	High	Negative	Possible	Major	High	Negative
Change in housing	Possible	Minor	Medium	Neutral	Possible	Minor	Medium	Neutral

[1] For definitions of likelihood of impacts and consequences of impacts see GHD (2013).

4. Summary and recommendations

Coal mining has a strong impact on environment, social and economic systems. Both UG and OC coal mining create substantial social costs. UG mining is generally associated with AMD, subsidence and occupational hazards such as accidents and coal workers' pneumoconiosis. OC mining is generally associated with the following impacts: fugitive dust, destruction of the environment, failed reclamation of mined land, noise and vibration, and accidents. Coal mine fires can occur in both OC and UG mines and in some abandoned mines fires can burn for many years potentially impacting vegetation, wildlife, and contributing to GHG emissions.

While air pollution from dust is higher in OC mines, the UG workers have a higher rates of pneumoconiosis than OC workers due to a higher exposure to the coal dust. Furthermore, methane emissions are higher from the UG mines than from OC mines. Methane emissions contribute to the global warming and can be a workplace hazard due to their toxicity and potential to explode.

Additional costs such as the costs of healthcare, water treatment, air pollution, not efficient reclamation, displacement are likely to be met by local, state or national government.

The full social costs of coal mining can be estimated using a range of market and non-market valuation techniques. When data are not available, then the comparison analysis can be performed. This paper suggests a methodology that can be used to compare impacts for specific coal mining projects. In the example provided the social cost of UG mining is less than the social cost of OC mining if no weighting to the costs are assigned. However, if accidents and subsidence are weighted higher than other costs, then the social cost of UG mining is higher than the social cost of OC mining.

Provided that social cost of mining is only a part of the full social cost of coal, social costs of coal mining should be considered as a part of the full life cycle of coal where the impacts of coal transportation, combustion, waste disposal, electricity transmission and climate change are taken into consideration. The full social cost of coal should also be compared with the full social cost of renewable energy generating technologies such as solar, wind and biomass.

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5. References

Altun, A., I. Yilmaz and M. Yildirim (2010). "A short review on the surficial impacts of underground mining " Scientific Research and Essay **5**(21): 3206-3212.

Downing, T. (2002). Avoiding New Poverty: Mining-Induced Displacement and Resettlement, World Business Council for Sustainable Development.

Dukka, P., S. Mahatha and P. De (2004). "A methodology for cumulative impact assessment of opencast mining projects with special reference to air quality assessment." Impact Assessment and Project Appraisal **22**(3): 235-250.

Epstein, P., J. Buonocore, K. Eckerle, M. Hendryx, B. Stout III, R. Heinberg, R. Clapp, B. May, N. Reinhart, M. Ahern, S. Doshi and L. Glustrom (2011). "Full cost accounting for the life cycle of coal." Annals of the New York Academy of Sciences **1219**: 73-98.

Fernandes, W. (2007). Mines, Mining and Displacement in India. Managing the Social and Environmental Consequences of Coal Mining in India. G. Singh, D. Laurence and K. Lahiri-Dutt. Dhanbad, The Indian School of Mines University**:** 333-344.

GHD (2013). North Galilee Basin Rail Project: Environmental Impact Statement. Chapter 16: Social and economic impacts, Report for Adani Mining Pty Ltd: 97. http://eisdocs.dsdip.qld.gov.au/North%20Galilee%20Basin%20Rail/EIS/Volume%201%20-%20Chapters/16%20Social%20and%20economic%20impacts.pdf (http://statedevelopment.qld.gov.au/assessments-and-approvals/north-galilee-basin-rail-projects-environmental-impact-statement.html)

Harris, J., P. Kirsch, M. Shi, J. Li, A. Gagrani, A. Krishna, A. Tabish, D. Arora, K. Kothandaraman and D. Cliff (2014). Comparative Analysis of Coal Fatalities in Australia, South Africa, India, China and USA, 2006-2010. 14th Coal Operators' Conference. The Australasian Institute of Mining and Metallurgy & Mine Managers Association of Australia**:** 399-407.

Ivanova, G. (2014). "The mining industry in Queensland, Australia: some regional development issues." Resources Policy **39**: 101-114.

Ivanova, G. and J. Rolfe (2011). "Assessing development options in mining communities using stated preference techniques." Resources Policy.

Ivanova, G., J. Rolfe, S. Lockie and V. Timmer (2007). "Assessing Social and Economic Impacts Associated with Changes in the Coal Mining Industry in the Bowen Basin, Queensland, Australia." Management of Environmental Quality: an International Journal **18**(2): 211-228.

Joyce, S. (1998). "Major Issues in Miner Health." Environmental Health Perspectives **106**: A538-A543.

Malgot, J. and F. Baliak (2004). "Influence of Underground Coal Mining on the Environment in Horna Nitra Deposits in Slovakia." Hazardous Geological Processes in Civil Engineering, Engineering Geology for Infrastructure Planning in Europe **104**: 694-700.

Mintz, R. (1976). "Strip Mining: A Policy Evaluation." Ecology Law Quarterly **5**(3): 461-529.

Munnik, V., G. Hochmann, M. hlabane and S. Law (2010). The Social and Environmental Consequences of Coal Mining in South Africa: a case study. The Netherlands, Environmental Monitoring Group

PADEP (1996). Centralia Mine Fire. Abandoned Mine Reclamation, Pennsylvania Department of Environmental Protection (PADEP).

--------- (2008). Centralia Mine Fire Mercury Study Final Report, Bureau of Air Quality, Pennsylvania Department of Environmental Protection (PADEP)**:** 1-21.

Sahu, H., N. Prakash and S. Jayanthy (2015). "Underground Mining for Meeting Environmental Concerns – A Strategic Approach for Sustainable Mining in Future." Procedia Earth and Planetary Science **11**: 232-241.

Sisodia, A. (2013). Soil and Water quality monitoring in opencast mines. A thesis submitted in partial fulfillment of the requirements for the degree of bachelor of technology in mining engineering, National Institute of Technology.

WorldBank (1998). India: Environmental Issues in the Power Sector. Joint United Nations Development Programme. Energy Sector Management Assistance Programme. Washington, DC 20433, World Bank.

Cumulative effects assessment is not so SIMPle

Authors

Katherine Witt, k.witt@uq.edu.au, University of Queensland, Australia
Will Rifkin, w.rifkin@uq.edu.au, University of Queensland, Australia
Lara Mottee lara.mottee@students.mq.edu.au, Macquarie University, Australia.
Jo-Anne Everingham, j.everingham1@uq.edu.au , University of Queensland, Australia

Abstract

As Social Impact Assessment (SIA) practitioners operate within the bounded context of government legislation and approvals process, and requirements for their industry client, there is a practical limitation in the assessment process for major developments in addressing cumulative impacts of multiple projects. Operating within these limitations brings into question the extent to which predictions made in a pre-project SIA match an academic analysis of cumulative, post-project outcomes, particularly when a project is assessed in the context of nearby developments occurring in a similar timeframe. With a focus on housing, this paper compares the results of a University of Queensland study into the cumulative socioeconomic impacts of multiple, billion-dollar plus, coal seam gas developments in Queensland, Australia with the predictions of likely social impacts published in the social impact management plans (SIMPs) of selected resource companies While predictions about the nature of impacts were reasonably accurate, the severity and timing of the impacts, that contributed to their cumulative dimensions, were misjudged leaving long-term social implications for affected communities.

Introduction

Resource companies as well as regulators are placing increasing emphasis on considering and accounting for the needs of affected rural and regional communities in the project planning and approval process (Owen & Kemp 2012, Department of Infrastructure and Planning (DIP) 2010). Such shifts call for social impact assessment (SIA) methods that can both capture community concerns and respond to changes associated with rapid development of multiple, large resource projects in a single region, as has occurred with coal seam gas (CSG) development in Queensland. This shift requires not only a change in SIA methods, but also improved mechanisms to manage and measure cumulative socio-economic impacts.

Cumulative impacts are defined by Franks, Brereton and Moran (2010, p. 300) as, 'the successive, incremental and combined impacts of one, or more, activities on society, the economy, and the environment.' Cumulative impacts can result from the aggregation of impacts, and they can vary in temporal and spatial extent reflecting the complexity of multiple, simultaneous initiatives undertaken by different companies. This 'nonlinearity' means that cumulative impacts may trigger or be associated with tipping points, where a small additional impact can create a much larger, systemic change to environmental, social and economic systems (Franks, Brereton & Moran 2010, Uhlmann et al. 2014). Cumulative impacts also result from the interactions of new impacts with existing processes and practices, such as new gas development in an existing agricultural region experiencing drought and flood.

Cumulative socio-economic impacts caused by rapid resource development are challenging for regulators and industry. They can have lasting negative or positive impacts on communities depending on how they are managed (Centre for Coal Seam Gas (CCSG) 2015). In recent years, the management of these impacts in the resource industry - notably in Queensland - has been through

individual Social Impact Management Plans (SIMPs) for particular developments at individual locations. The SIMP's effectiveness can be hindered by the complexity of interactions of cumulative impacts (Franks et al. 2010). We argue for the coordination of an adaptive management approach that accommodates 'shared management' to monitor and respond to the cumulative socio-economic impacts of multiple resource projects in a region

Cumulative impacts of coal seam gas projects in Queensland

In the Western Downs region of Queensland, four major companies each initiated large projects to extract, transport and convert coal seam gas to liquefied natural gas (LNG). Together, they comprise one of the largest corporate investments in the southern hemisphere (Fensom 2012). While these projects are at various stages of development, all have included major phases of exploration and construction of the necessary infrastructure (e.g., wells, pipelines and roads) before becoming fully operational. Communities closest to the CSG development have been the most noticeably impacted by the projects, with rapid population growth during the exploration and construction phases creating immediate demands for services, housing and infrastructure. Many of these impacts were seen to have been beyond the towns' response capacities (Uhlmann et al. 2014). Rapid change can lead to a reduction of community cohesiveness, social instability and the perception that personal wellbeing is in decline (Jacquet 2009; Smith, Krannich & Hunter 2001; Rifkin et al. 2015).

The initial period of intense construction activity ended in 2014. The projects have transitioned to a more long-term operational workforce, leaving towns with significant changes in housing and commercial infrastructure, altered human networks and shifted population demographics. Recent data suggests that crime rates are increasing, perhaps coinciding with low-income families arriving to take advantage of low rents caused by a housing oversupply. Average incomes increased in some towns during the construction period, but the distribution of wealth appears to be skewed, with more welfare-dependent families arriving. Such outcomes highlight the complexity and diffuse nature of cumulative impacts that make allocating responsibility for their mitigation to any single project problematic for regulators.

Shortcomings of regulatory mechanisms

The Queensland government's approval process requires an environmental impact statement (EIS) for all large projects in Queensland. The EIS must include an SIA that is developed with community consultation to characterise the potential socio-economic impacts and benefits for affected areas. SIAs typically lead to the development of SIMPs. A SIMP outlines strategies that the company will take to mitigate predicted negative impacts of their project. It also specifies how they will measure and monitor any changes in these impacts over time. Often the SIMP management strategies prepared at the development application phase remain relatively static throughout the life cycle of a project (though some conditions can be adjusted by the regulator). Where monitoring feedback is obtained, a mitigation strategy can be adapted in response to observed changes. Such adaptation can be enhanced through the use of outcome indicators and monitoring methods incorporated within SIMPs. Indicator data provides proponents with the evidence required to demonstrate that they have achieved - or at least made satisfactory progress toward - the desired social outcomes at the conclusion of a project.

Current regulatory guidelines in Queensland state that the SIA must assess cumulative impacts resulting from the proposed project and other developments regionally. However, proponents are only required to mitigate impacts that are directly attributed to their own project. Furthermore, the guidelines state that mitigation measures are not required for existing issues and legacy issues that are not attributed to the project in question (DSDIP 2013). Further, cumulative impact assessment

sections of SIAs and SIMPs still state that there is no common, accepted method for conducting a cumulative impact assessment.

Thus, there is a practical limitation in the project assessment process in considering cumulative impacts of multiple projects, as practitioners operate within this regulatory context. This situation raises questions about the extent to which a pre-project SIA would match a university-led analysis of cumulative, post-project outcomes. Also, if an SIA is based upon best available information at the time of writing, is it possible to improve prediction, quantification, and management of cumulative impacts using a more adaptive and responsive assessment approach?

To address such questions, we have been studying the cumulative socio-economic impacts of coal seam gas (CSG) development in Queensland. The research team has selected a compact set of measurement indicators, which enable monitoring changes in affected communities in what aligns with an 'adaptive assessment' approach. The UQ Boomtown Toolkit (https://boomtown-toolkit.org) identifies key indicators that can be utilised to monitor changes in community assets as a result of resource development. The primary indicators selected are based on a range of research work, including interviews with people in the affected communities, North American case studies, and international development of sustainability indicators. Data is collected on a period of 15 years to capture periods prior to, during and after the CSG industry's peak construction period in this region. The data are from publically available databases, such as the Australian Population Census.

Predicted vs Measured Outcomes

We use housing impacts as an example to show that while the SIA process was able to predict the nature of impacts with reasonable accuracy, it could not adequately account for the timing or the severity of impacts. These facets represent the cumulative dimension of impacts when they are influenced by factors that, while interconnected, are exogenous to the project, such as outside investors funding new housing development egged on by hype about high rental returns.

The SIMP predicted that there would be demand for approximately 250 additional houses, and that this increased demand would potentially impact on housing availability and affordability. It also predicted that the potential cumulative demands on housing due to multiple CSG construction projects could result in increased housing stress for low-income households, requiring some households to relocate away from the region. It was predicted that low income households could experience increasing difficulty in maintaining secure housing.

The cumulative impacts study found that rents for a 3-bedroom house in some towns (Miles, Wandoan and Chinchilla) doubled or nearly tripled in the 3-4 years from pre-CSG in 2008 to the peak construction period in 2012/13. The SIMP did not predict that higher house sale prices would motivate some (particularly older) people to sell and move away. It did not note that high rents would trigger a real estate 'boom' with increases in private sector property investment and development activity. These forces combined with the project approval condition placed by the Queensland government on a resource company to build new houses to accommodate the predicted additional need of its own staff (though not contractors) and to fund construction of affordable housing, given the expected rise in rents. These strategies have resulted in a housing oversupply in some towns, with residents of one town of 6,000 residents being keenly aware of how many empty rental properties there are. The time lag between the immediate need for housing once the project was approved and the 2-year period for housing approvals, development and construction was underestimated. The time lag and developer hype resulted in oversupply, and both rents and house prices have dropped significantly since the construction period ended in 2014 (Figure 1).

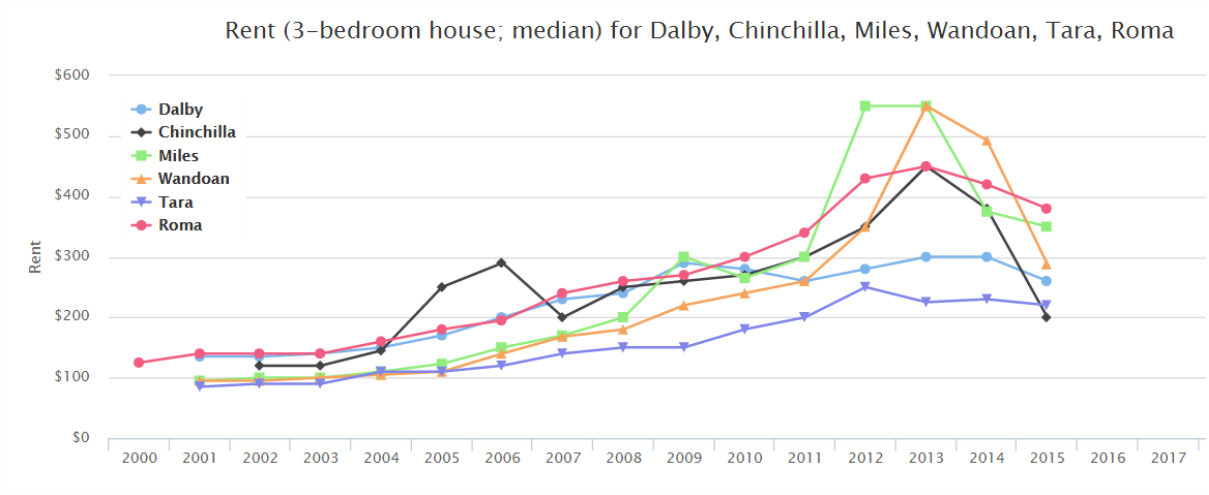

Figure 1: Rents increased and then decreased significantly in a short period of time.

Figure 2 suggests that very low rents and plentiful housing are attracting lower-income families to the towns. Interviews with school principals and community workers in these towns revealed the perception that many of the new residents have higher needs in terms of health and educational support, which can stretch local services. Neither of these impacts can be attributed to any single CSG project.

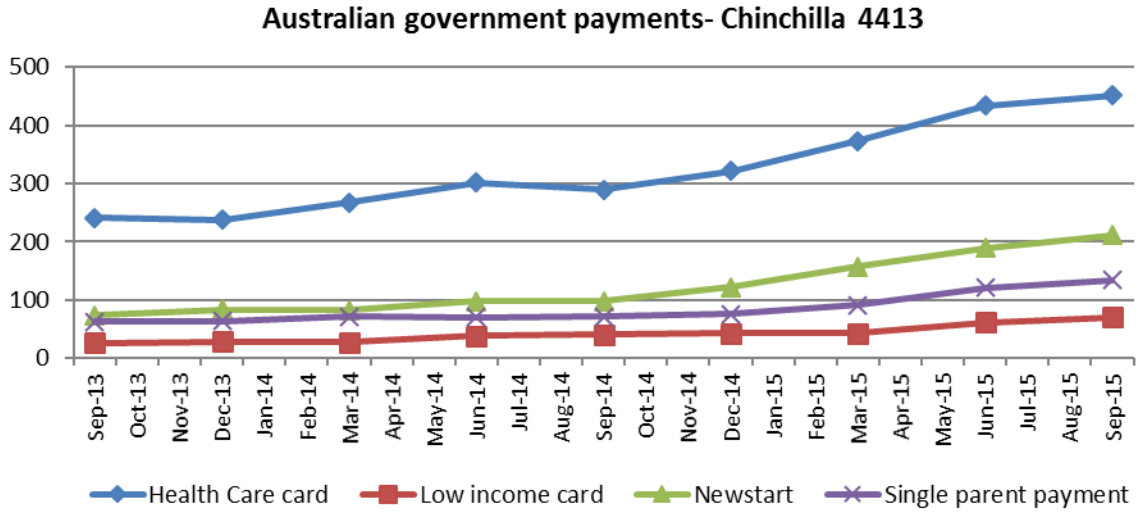

Figure 2: Since the end of the construction period in 2014, the number of people receiving Government payments has increased. The Newstart allowance is for unemployed persons.

Shared Management and Strategic Monitoring Framework

The analysis of trends across the indicators highlights the need for a focus on assessing cumulative impacts at the town level. It also suggests the importance of coordination across impact assessment studies in a region to contribute to an overarching monitoring framework. The trends and impacts highlighted in Figures 1 and 2 demonstrate that the prediction of socio-economic impacts during the SIA process may be generally accurate during construction. However, they also suggest that the experiences at the township level can be highly varied. That is, different towns can have different experiences, and different socioeconomic segments in a single town can have different experiences. The application of the toolkit indicators to illustrate these town-level impacts show that the nature of the impact on the region was more significant than predicted. Additionally, the lasting benefits

from additional housing, for example, have not yet been realised, quite the opposite, with near-term challenges.

These results indicate that there was an aggregated socio-economic impact from multiple projects in the region during the construction period. Had the analytical approach that we employed – and examples of its use - been available prior to the CSG development, a more adaptive assessment and management approach may have helped to mitigate some of these negative impacts.

Rifkin et al. (2015) note that coordination among industry operators and between them and government are required. That can help to address uncertainty surrounding potential cumulative impacts and managing resulting negative social outcomes from resource development, particularly when multiple projects are pursued in a given region. A shared management approach can address a sector's cumulative outcomes and provide means for collaborating to achieve shared goals (Ogain et al. 2013). In the case of the CSG sector, the shared goal is minimising the negative socio-economic impacts on local communities from the CSG projects, and enhancing long-term, positive legacies.

Such common goals are a foundation stone of a shared management system, including a strategic, adaptive, monitoring framework. The UQ toolkit, whose findings are illustrated here in assessing housing impacts, is an example of such an adaptive assessment approach. It is now being used to provide strategic monitoring for management of CSG socio-economic impacts, albeit on an emerging and voluntary basis. The Toolkit, or other such adaptive approach, provides a shift of focus away from the individual projects and individual business strategies, toward a more strategic approach to achieving a common social purpose.

References

Centre for Coal Seam Gas (CCSG) 2015, *What are key cumulative socio-economic impacts of CSG development and how do we track them to inform planning?* viewed 18 May 2016,

http://www.ccsg.uq.edu.au/Research/SocialPerformance/CumulativesocioeconomicimpactsofCSG.aspx

Department of Infrastructure and Planning (DPI) 2010, *Social impact assessment Guideline to preparing a social impact management plan*, viewed 27 September 2015,

http://www.statedevelopment.qld.gov.au/resources/guideline/simp-guideline.pdf

Department State Development, Infrastructure and Planning (DSDIP), 2013, *Social impact assessment* guideline, July 2013, State of Queensland, 100 George Street, Brisbane Qld 4000. (Australia)

Fensom, A. 2012, Queensland CSG Industry pushes obstacles aside, *Queensland Mining and Energy Bulletin*, Spring, pp75-79.

Franks, D., Brereton, D., Moran, C., Sarker, T., Cohen, T., 2010, *Cumulative Impacts – A Good Practice Guide for the Australian Coal Mining Industry, Australian Coal Association Research Program*. Centre for Social Responsibility in Mining and Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland, Brisbane.

Franks, D., Brereton, D. and Moran, C., 2010, 'Managing the cumulative impacts of coal mining on regional communities and environments in Australia'. *Impact Assessment and Project Appraisal*. vol. 28, no. 4, pp.299–312.

Jacquet, J. B. 2009, *Energy Boomtowns and Natural Gas: Implications for Marcellus Shale Local Governments and Rural Communities NERCD Rural Development Paper No. 43*: The Northeast Regional Center for Rural Development, The Pennsylvania State University.

Ogain, E., Svistak, M. & Casas, L. 2013, *Blueprint for shared measurement. NPC for Inspiring Impact*, London. Viewed 30 September 2015, http://www.thinknpc.org/publications/blueprint-for-shared-measurement/

Owen, J.R., Kemp, D., 2012 'Social licence and mining: A critical perspective', *Resources Policy*, http://dx.doi.org/10.1016/j.resourpol.2012.06.016

Rifkin, W., Witt, K., Everingham, J. and Uhlmann, V. 2015, Lessons CSG Operators can learn from Southern Queensland Towns, *Gas Today*, Autumn 2015.

Smith, M. D., Krannich, R. S., & Hunter, L. M. 2001, 'Growth, decline, stability, and disruption: A longitudinal analysis of social well-being in four western rural communities', *Rural Sociology*, vol. 66 no.3, pp. 425-450.

Uhlmann, V., Rifkin, W., Everingham, J., Head, B., May, K., 2014 'Prioritising indicators of cumulative socioeconomic impacts to characterise rapid development of onshore gas resources', *The Extractive Industries and Society*, vol. 1, no. 2, pp. 189-199.

Modifying the Project EIA Framework for a Large-Scale Dam Removal Project

Gordon Yamazaki[1] (UNB), Matthew Kinnie (Stantec Consulting Ltd.), Andy Small (amec foster wheeler), Gregory Gillis (amec foster wheeler), and Jeffrey L. Barnes (Stantec Consulting Ltd.).

Introduction

The rapidly growing need for the removal or renewal of large dams in North America requires new and innovated approaches to environmental impact assessment (EIA). This is particularly the case for large-scale dam removals that may have environmental impacts on a geographic scale that far exceed what is typical for project EIA. Further complicating the use of standard assessment methods is that the environmental impacts are often significant by design and intent and not mitigable using standard approaches. Large rivers often form political boundaries where cross-boundary impacts may occur or may have diadromous fish stocks that migrate across management boundaries. Finally, hydroelectric dams may be vital components to climate change management programs as they may regulate greenhouse gas emissions and control flooding. For these reasons it is important to have an EIA framework that is capable of incorporating elements of strategic environmental assessment (SEA), for the consideration of regional and cross-boundary policy initiatives and regulation, and will benefit from the inclusion of adaptive management in the project description and at each stage of assessment.

This paper describes the use of such a framework as applied to the EIA[2] of the Petitcodiac River dam and causeway located in the tri-community area (Moncton, Riverview, Dieppe) in New Brunswick, Canada. Although the framework differed from that of project EIA, the paper emphasizes the attempt to incorporate SEA within the cumulative effects assessment (CEA).

Impetus for the EIA

Where it empties into the Bay of Fundy, the Petitcodiac River estuary is unique in the world for its 11 m average tides and natural suspended sediment loading regularly exceeding 30,000 mg/L. Historically, important as the primary breeding and rearing grounds for the now endangered Inner Bay of Fundy strain of Atlantic Salmon, its freshwater habitats were effectively cut off from the marine environment by the installation of a dam and causeway between the Town of Riverview and City of Moncton in 1968. As early as 1961, scientists with Fisheries and Oceans Canada (DFO) warned of the potential adverse impacts that such a

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[1] Gordon was the case study EIA technical writing coordinator and implementation environmental manager during his tenure with Stantec Consulting Ltd. He is currently the Project Manager of the Mactaquac (Dam) Aquatic Ecosystem Study at the University of New Brunswick, Fredericton, Canada.

[2] The EIA was undertaken by AMEC Foster Wheeler, Stantec Consulting Ltd., Gemtec and the New Brunswick Department of Supply and Services (AMEC 2005).

development would have on several diadromous fish species (Elson 1961), in particular the highly valued Atlantic Salmon. The 40 years that followed the commissioning would prove these warnings correct as extreme sediment transport and deposition in the upstream direction from tidal forces blocked all attempts at providing fish passage at the structure.

The Petitcodiac Riverkeeper was launched in 1999 with the restoration of fish passage at the causeway established as one of three initial priorities and they were steadfast in their determination to move government towards remediating environmental problems in the Petitcodiac River. They documented a history of such problems resulting from installation of the dam and causeway as studied by various government and academic institutions, gathered the support of most local communities, and proceeded to notify DFO of their intent to begin legal action to enforce the *Fisheries Act.* These actions ultimately led DFO to appoint a Special Advisor (Eugene Niles) to review and report on the fish passage non-compliance issues.

The Niles Report (2001) included historical review and consultation results with discussion and recommendations. It identified five potential options for addressing the fish passage issue and recommended a specific option (i.e., replace the dam and causeway with a bridge) proceed to EIA. The Niles Report did determine that fish passage at the dam did not work for most species but also added several other ecosystem and social issues with the dam and causeway identified during the public consultation process. Although the Niles Report relied solely on historical information and consultation, lacking establishment of a current baseline and a rigid assessment framework, it ultimately failed as a stand-alone option selection process for such a contentious and environmentally impacting project. It was evident that more consideration of the options was required and DFO and the Province of New Brunswick called for an EIA (screening and comprehensive, respectively), and the two were carried out in a harmonized manner.

The EIA guidelines (NBDELG 2002) carried forward four of the Niles Report options: 1) replace the fishway; 2) gates open during peak migration; 3) gates open permanently; and 4) replace the causeway with a bridge. The fifth option of the Niles Report—the status quo[3]—was included for comparative purposes. The guidelines also established clear project objectives as: "The modifications…are intended to achieve a long-term solution to fish passage and other ecosystem issues related to the causeway, including tidal exchange, sediment transport and other physical processes, and biophysical functions...". Hence, it was now the responsibility of the proponent to not just address fish passage concerns but also to remediate a diverse scope of issues, while selecting from four distinct project options, transparently with extensive public input. It was clear that a new EIA framework was required.

[3] DFO removed the status quo from the list of options because it was already determined to be in violation of Section 20 of the *Fisheries Act*.

Modified EIA Framework Methods and Scoping

For the purpose of selecting between distinct options, the weaknesses of project EIA are well known. While project EIA can excel in the identification of mitigation for typical development projects, the framework can be inadequate for evaluating the complexity of large-scale projects with multiple distinct options where the intent of the project is to produce (or remediate) significant impacts. Where this is the case, a modified EIA framework that emphasizes an adaptive management approach and includes elements of SEA may be better suited.

Despite the decision making process sharing many of the methodological and procedural elements of the equivalent model (Partidário 2000[4]) of SEA, including consideration of sustainable development within the watershed region, the project EIA framework was selected as the basis for the impact assessment because: a) it was mandated by the project guidelines (NBDELG 2002); and b) the project was not proactively linked to policy development or evaluation. However, owing to the immensity in magnitude and geographic extent of the impacts and their connection to sustainable development, and the potential for the project to manage some climate change issues in the region, some elements of SEA were incorporated into the CEA where proposed changes in policies and regulation were considered along with regionally existing or planned management of climate change and marine fisheries.

To tighten the scope of the assessment from the vague requirements of the EIA Guidelines, the proponent proposed design criteria early in the EIA process that improved the transparency of the EIA process by establishing clear objectives for addressing the other ecosystem issues requirements of the EIA Guidelines. The design criteria were fundamental to options evaluation in making a clear case for the elimination of the two options that did not widen the channel and improve tidal exchange.

From the beginning, public consultation was central to the project options evaluation. The EIA proponent established the first ever project-specific EIA website in New Brunswick which at its peak was receiving tens of thousands of hits per day. Several workshops were held with relevant stakeholders to educate them in key aspects of the assessment such as hydrodynamic and sediment transport modelling. Open houses of various types were held regularly throughout the potentially affected communities, including further abroad in commercial fishing villages and ports.

[4] Reference taken from Partidário (2000) in which the author attributes the definition of the *equivalent* (environmental appraisal) model, where policy and plan evaluation are undertaken to identify and take account of environmental effects, to Sadler and Verheem (1996).

The establishment of baseline and future conditions was a large-scale multi-year undertaking and was scoped broadly to include impacts of all options though ultimately limited geographically to the jurisdiction of Canada. The primary objective was improving the acceptability of the outcome of the EIA through robust studies that followed the guidance of both regulators and input from the public workshops.

The project description included an interim gate opening 'trial' period in which the follow-up program could be initiated and results considered prior to finalizing project detailed design. Incorporating this time-stepped approach in the project design allowed for true adaptive management. For example, a sediment budget program greatly improved confidence in the EIA predictions and allowed for a significant reduction in project costs related to sediment relocation and management.

The CEA was atypical because the magnitude and extent of project impacts were so great that contributions from other typical projects were mostly negligible. The CEA attempted initially to follow the common guidance document in Canada (Hegmann et al, 1999) but in so doing found the approach limited by its definition of "actions" which was based on the concepts of "physical works" and "physical activities" as contained within the Canadian Environmental Assessment Act (CEAA 1992) in place at that time. This focus on the physical interactions with other projects and activities failed to consider other policies, plans, programs and management objectives within the vast area of impact. Thus, in addition to considering the typical and required other physical projects and land use actions, the CEA framework was adapted to include changes in policy and regulation in a manner more consistent with SEA. In this way, the CEA was able to apply a VEC-centered lens taking into account a broader array of human activities and avoiding many of the common shortcomings of CEA in EIA (Duinker and Greig, 2005).

The Follow-up Program (FUP) allowed for adaptive management at each of three stages: 1) establishing baseline; 2) monitoring during a trial period; and 3) monitoring following the construction of the bridge. The trial period was planned as a two-year duration; however, changes in federal and provincial governments with differing funding priorities resulted in an extended gate-opening period. The extended trial period and FUP proved essential to mitigating unexpected impacts and informing design. For example, the follow-up program during the trial period identified fecal coliform issues that were not accurately predicted which led to increased rigor and new technologies (DNA-marker species identification) to be implemented in the follow-up program.

Unintended Benefit of the Framework

During the EIA process, the fourth option was split into three distinct options thereby increasing the total number of options under evaluation from four to seven. Multi-option evaluation led to EIA approval of four options, which provided subsequent design flexibility for adaptive management. During the detailed design

process, and the FUP, it was determined that some aspects of the design required modification from the original plans. Being able to adjust the design between the limits of the four approved options without need for further assessment or consultation greatly improved the efficiency of the design process and ultimately reduced the cost and the environmental remediation success of the project.

Conclusions and Recommendations

The modified EIA framework was successful at providing an options selection process that satisfied the project objectives in a manner that was transparent and the public remained engaged throughout. The entire process, from EIA through implementation, has spanned three very different governments and new criticisms and challenges imposed by each. The inclusion of SEA elements and adaptive management were invaluable aspects of the framework and should be considered for inclusion in future dam removal EIAs.

The inclusion of multiple options within the EIA promoted flexibility at the design and implementation stages that improved efficiency and reduced overall costs. Alternatively, where decisions are required on rivers with multiple dams, the application of SEA should be explored as a management tool at the regional level followed by site-specific single-option project EIAs.

REFERENCES

AMEC. 2005. Environmental Impact Assessment Report for Modifications to the Petitcodiac River Causeway. New Brunswick Department of Supply and Services, Document YB299A.

Duinker, P. and Grieg, L. 2005. The Impotence of Cumulative Effects Assessment in Canada: Ailments and Ideas for Redeployment. Environmental Management, 27(2), 153161.

Elson, P.F. 1961. Proposed Moncton Causeway-aboideau in Relation to Anadromous Fish of the Petitcodiac System. Unpublished report, Fisheries Research Board of Canada. January 31 1961. 9 p.

Hegmann, G., Cocklin, C., Creasey, R., Dupuis, S., Kennedy, A., Kingsley, L., Ross, W., Spaling, H., Stalker, D. 1999. Cumulative Effects Assessment Practitioners Guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group, Canadian Environmental Assessment Agency, Hull,Quebec.

Niles, Eugene. 2001. Review of the Petitcodiac River Causeway and Fish Passage Issues: Final Report. Prepared for Fisheries and Oceans Canada by E.J. Niles & Associates, New Brunswick.

New Brunswick Department of Environment and Local Government (NBDELG). 2002. Guidelines for an Environmental Impact Assessment: Modifications to the

Petitcodiac River Causeway. Issued by the Minister of the Department of the Environment and Local Government for the Province of New Brunswick and Fisheries and Oceans Canada. July 26, 2002.

Partidário, Maria R. 2000. Elements of an SEA Framwork—Improving the Added-Value of SEA. Environmental Impact Assessment Review. 20 (2000) Pages 647-663.

Sadler, B., and Verheem, R. 1996. Strategic Environmental Assessment—Status, Challenges and Future Directions. The Hague: Ministry of Housing, Spatial Planning and the Environment of the Netherlands, 1996.

The Need for Strategic Environmental Assessment for Carbon Capture and Storage in Japan

Presenting Author: Kenichiro Yanagi,

Coauthors: Eiji Komatsu and Akihiro Nakamura

Introduction

The Paris Agreement came into force on 4 November 2016. This agreement, for the first time, brought all nations together to share the responsibility of combatting climate change and adapting to its effects (UNFCCC 2016). In order to achieve the target of keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels, there has been wide discussion about Carbon Capture and Storage (CCS) considered as one of the significant approaches to mitigating a large amount of CO_2 from the global atmosphere (GCCSI 2016a; and Streck et al 2016). However, the current status of the world has yet to be widely demonstrated at a commercial scale, and CCS implementation has still been low (UNECE 2016). It is a key challenge for nations and investors to understand the technology and benefits, and governments are responsible to prepare for a relevant policy framework for CCS. This paper aims at reporting a part of the progress under our nationally funded research project, which is to develop a comprehensive policy and legislative framework for commercialising CCS in Japan. This paper specifically suggested that a Strategic Environmental Assessment (SEA) would play a significant role in assisting Japan's future framework. Firstly, this paper will describe the significance of a CCS policy and programme and SEA for CCS. It will then review Japan's context by addressing the current status of CCS deployment, and issues under the current legislation applicable to CCS. This will conclude this paper.

CCS Policy and Programme

In terms of a CCS policy, it is essential to analyse the social, environmental and economic aspects, which enable us to contribute to reducing the Greenhouse Gas (GHG) emissions at the national level. The policy also needs to achieve a low carbon society with middle and long-term vision (IEA 2012). These will reduce the GHG emissions by promoting/implementing CCS, but also the technology will create a cleaner coal-fired power system, and/or bioenergy with CCS (IRENA 2013). IEA-GHG (2007) acknowledged that CCS deployment would potentially create: direct and/or indirect impacts on environmental, economic and social aspects in conjunction with short, middle, long term and permanent influences; and cumulative impact, secondary effect and/or incidental impact. Thus, it is essential to conduct a review process such as an Environmental Impact Assessment (EIA) on each CCS project to identify any significant environmental issues during the permit process. SEA is a similarly structured

approach to EIA but considers a policy and regulatory decision for implementing multiple projects. Thus, both EIA and SEA are significant processes when considering CCS deployment.

The Significance of SEA for CCS

SEA has already been adopted and implemented in a number of countries, including the European Union (EU) countries, the United States and Canada. The EU enacts the SEA Directive, providing a basis of SEA framework applied to plan /programme making. SEA is a part of EIA and provides an opportunity for a country to assess environmental impacts at the planning stage. Both EU-EIA and EU-SEA Directives are individually enacted under the EU legislation. A result from SEA helps EIA to enable an efficient process and information transparency. However, although the EU-CCS Directive requires a process of EIA, it does not refer to the SEA in its requirements. CCS projects are key developments under energy policies, thus a comprehensive approach to making a decision is unavoidable. Therefore, CCS should be reviewed by both EIA and SEA (IEA-GHG 2007). The United Kingdom (UK) government has followed the basis of the Directives for its national activities, and SEA has been included with CCS, as one of the key development areas for the national practice.

The UK government is committed to the reduction of GHG emissions by 80% on 1990 levels by 2050, as implemented in the *Climate Change Act 2008*. The UK was also involved in the Paris Agreement. Energy production is a major source of GHGs, and the UK has faced a key challenge for developing energy and climate change policies to meet their legally binding UK targets and internationally agreed goals. To achieve those, the government intends to increase energy supply from renewable sources, cleaner coal, biomass or gas-fired power stations and nuclear energy. The government acknowledged that cleaner coal and those fired power stations incorporated with CCS would significantly contribute to achieving its policy outcomes. The National Policy Statements for Energy also target almost all the possible opportunities for renewable energy projects for the country's benefit (e.g. CCS, gas storage and oil and gas pipelines) (DECC 2015).

Most recently, the UK Department of Energy and Climate Change (DECC) prepared an 'environmental report' as part of its Offshore Energy Strategic Environmental Assessment [OESEA] programme. OESEA3 is implemented under *Environmental Assessment of Plans and Programmes Regulations 2004* (the SEA Regulations), which apply to any relevant plan/programme relating either solely to the whole or any part of England, or to England and any other part of the UK. OESEA3 assessed a draft plan/programme to hold further offshore leasing/licensing for renewable energy, oil & gas, hydrocarbon gas and CCS and associated infrastructure (DECC 2016).

CCS Project Scheme in Japan

Japanese government submitted Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015. Japan decided the GHG reduction target of 26% by 2030 below 2013 level, ensuring consistency with its energy mix, set as a feasible reduction target by bottom-up calculation, with concrete policies, measures and individual technologies taking into adequate consideration, *inter alia*, technological and cost constraints, and set-based on the amount of domestic emission reductions and removals assumed to be obtained (MoFAoJ 2016). The government also targets an 80% reduction of GHG emissions by 2050. To achieve this, the government estimate shows that we will need to rely on introducing innovative technologies including CCS, innovative structural material, and/or artificial photosynthesis (Oshiro and Masui, 2014).

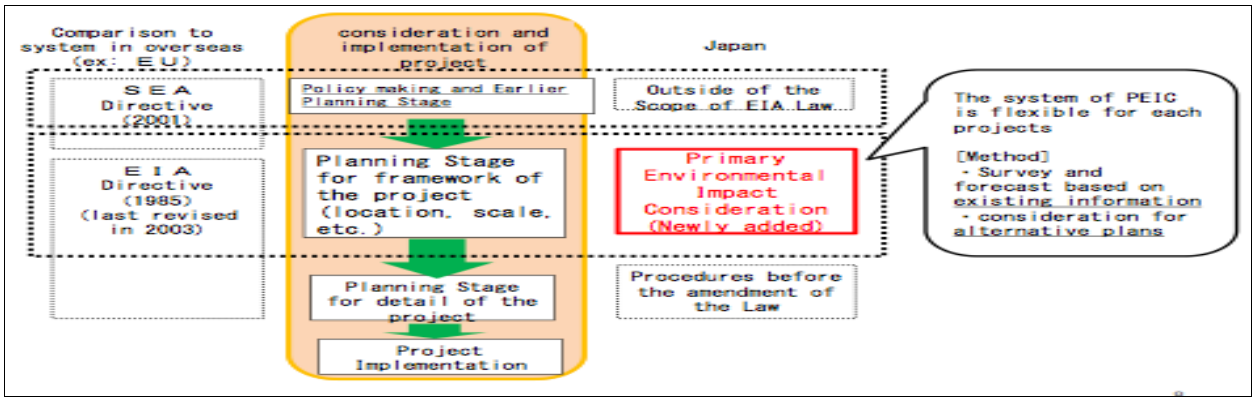
With regard to the potential of CCS in Japan, the existing boring data showed the potential storage capacity of approximately 5.2 billion t-CO_2 for relevant reservoir and 150 billion t-CO_2 in total value (Ito, 2008). Thus, as a key technology to contribute to meeting Japan's GHG reduction target, the government intends further research in order to commercialise CCS deployment by 2020, including a range of geological research on research development of large-scale CCS pilot projects and carbon separation/capture technologies, safety assessment, and storage site selection. The government also acknowledged that CCS Ready can further create cleaner coal fired power with the reduction of environmental impacts (METI, 2014). Currently, the Tomakomai CCS Demonstration Project has been endorsed by Japan's Ministry of Economy, Trade and Industry (METI) since February 2012. The project aims to demonstrate an overall CCS system from capture to storage as a basis for commercialising CCS from 2020. It intends to inject 100,000 tonnes or more of CO_2 per annum in the first two reservoirs located at the depths of approximately 1000 - 3000m, under the seabed of the offshore area of Tomakomai Port over the period 2016-2018 (Japan CCS Co., Ltd 2016).

From the legislative perspective, the amendment of 'the Act on Prevention of Marine Pollution and Maritime Disaster' in 2007 considers the future CCS. In particular, this law only requires security for 'injection and storage' and 'closure and post-closure'. Furthermore the law only accepts an operator for a licence of 'storage' and/or 'waste' up to maximum 5 years, thus it has not yet considered the long-terms management after post-closure including transfer of site closing and security, and long-term liability (Nakamura 2007; and GCCSI 2016b). There is a need for an appropriate energy and climate policy in order for Japan to commercialise the technology. In this regard, it is important to set a specific target indicating how much reduction of CO_2 emission CCS can contribute, and to establish a comprehensive legal framework (i.e. long-term management and liability) (IEA 2012).

Issues of SEA for CCS Plan/ Program in Japan

In Japan, the EIA Law was amended in April 2011. The law provides an opportunity to review significant environmental impacts for multiple development plans at the early stage, involving consultation processes by the responsible minister, related authorities and the public. The results help in decision-making, which enables prevention and/or reduction of any potential environmental impacts (MoE 2012). However, the law does not provide a comprehensive framework such as SEA, which is widely implemented in a number of countries especially among EU members. SEA does not only aim at considering the environmental aspect, but also social and economic aspects at the planning stage (Yanagi, 2011). In particular, the UK's SEA often applies to plan/programmes but also policies. As mentioned previously, the UK's OESEA3, has considered a number of specific energy policy and plan/programmes including CCS. Such a system has yet to be available under Japan's law. The table 1 shows the comparison of EIA & SEA Framework in EU and Japan.

Table 1: Comparison of EIA & SEA Framework in EU and Japan



(Source: Ito 2014)

In order to implement CCS in Japan, the relevant data will be collected to select the most specific and appropriate storage sites. Furthermore, it is important for us to consider: the characteristics of CCS sites and operations; environmental, economic and social effects in conjunction with short, middle and long-term, and secondary, cumulative and synergistic effects of the implementation of the plan. As the government has recognised CCS as one of the significant tools to attain Japan's GHG mitigation target (Japan CCS Co., Ltd 2016), it is thus necessary for the government to make the right policy decision for implementing CCS by conducting a high level discussion at the earliest possible time. CCS provides a beneficial opportunity for considering the impacts of climate change and energy security. Therefore, SEA applied for CCS will be a significant tool to assist a relevant policy decision in Japan.

SEA provides a process, which helps us to select the relevant programme and the alternatives and to make a strategic decision-making at the planning stage. OESEA3 has considered a list of significant impacts, which are potentially affected by the draft plan/program and the alternatives for CCS operations. This process has thus been implemented to specify a list of impacts, and to review a potential impact by managing environmental conservation control, publication and public consultations as requested for the final decision in the future (DECC 2016). Table 2 below shows the evaluated receptor for EIA/SEA in the Act on Prevention of Marine Pollution and Maritime Disaster in Japan compared with the UK's SEA, based on the criteria under the OESEA3.

Table 2: Comparison of Evaluated Receptors in CCS between SEA in the UK and the Act on Prevention of Marine Pollution and Maritime Disaster in Japan/ Yanagi, Komatsu and Nakamura 2017

UK Offshore Energy Strategic Environmental Assessment	Act on Prevention of Marine Pollution and Maritime Disaster in Japan
Evaluated Receptor in SEA/EIA	
Biodiversity, habitats, flora and fauna	Biodiversity, marine flora and fauna
Geology, substrates and coastal geomorphology	(Not evaluated)
Landscape/seascape	(Not evaluated)
Water environment	Water/Seabed environment
Air quality	(Not evaluated)
Climate and meteorology	(Not evaluated)
Population and human health	(Not evaluated)
Other users, material assets (infrastructure, other natural resources)	Other users
Cultural heritage, including architectural and archaeological heritage	(Not evaluated)
Conservation of sites and species	(Not evaluated)
Interrelationships of the above	(Not evaluated)

The table clearly shows that EIA under the current legal framework in Japan relevant to CCS deployment, therefore has yet to be sufficient to evaluate the long-terms and secondary, cumulative effects by CCS as well as technical and social aspects as those listed in SEA such as the UK SEA. Given this, the circumstances leave a key challenge for making a comprehensive CCS framework in Japan. Although other legal aspects such as security and long-term liability still need to be developed, addressing those issues through a relevant SEA could assist in a better framework in order to commercialise CCS deployment in Japan.

Conclusion

Given this, there is an urgent need for a SEA system in Japan, which will play a significant role in establishing a comprehensive policy, legislative and regulatory framework to commercialize CCS in Japan. SEA enables not only avoiding and reducing any significant risks of the CCS plan, program and/or policy, but also enables making the most efficient way to implement and promote CCS in Japan.

References

DECC (The Department of Energy & Climate Change), 2015. "UK Offshore Energy Strategic Environmental Assessment (UK OESEA3)". Scoping for Environmental Report. July 2015.

DECC, 2016. "UK Offshore Energy Strategic Environmental Assessment". OESEA3. Post Consultation Report. July 2016.

GCCSI (The Global CCS Institute), 2016a. "Paris Agreement enters into force: CCS climate change mitigation role reconfirmed". https://www.globalccsinstitute.com/sites/www.globalccsinstitute.com/files/content/media_release/123393/files/Paris%20Agreement%20enters%20into%20force%20.pdf

GCCSI, 2016b. "Japan's legal and regulatory framework for CCS". 1st April 2016. Available at https://www.globalccsinstitute.com/insights/authors/MeredithGibbs/2016/04/01/japans-legal-and-regulatory-framework-ccs

IEA GHG (IEA-Greenhouse Gas R&D Programme), 2007. "Environmental Assessment For CO_2 Capture and Storage". Technical Study. 2007/1, March 2007.

IEA (International Energy Agency) 2012. "A Policy Strategy For Carbon Capture and Storage". OECD/IEA. Paris. France. January 2012.

IREA (International Renewable Energy Agency), 2013. "Biomass Co-firing in Coal Power Plants". IEA-ETSAP and IRENA, Technology-Policy Brief E21. January 2013.

Ito, Akito., 2008., "Current Status of CCS in Japan"., http://www.rite.or.jp/Japanese/labo/choryu/workshop/futuregenws2008/2008FGWS_MrITO.pdf. (in Japanese)

Japan CCS Co., Ltd 2016. "Tomakomai CCS Demonstration Project". Available at http://www.japanccs.com.

Ministry of Economy, Trade and Industry, 2014, "Cabinet Decision on the New Strategic Energy Plan". http://www.meti.go.jp/english/press/2014/0411_02.html. (in Japanese)

MoFAoJ (The Ministry of Foreign Affairs of Japan), 2016. "Intended Nationally Determined Contributions (INDC): Greenhouse Gas Emission Reduction Target in FY2030". 8th, September 2016. Available at: http://www.mofa.go.jp/ic/ch/page1we_000104.html

MoE (The Ministry of the Environment), 2012. "Environmental Impact Assessment in Japan". Environmental Impact Assessment Division. Government of Japan. Tokyo. Japan. Available at: https://www.env.go.jp/en/focus/docs/files/20120501-04.pdf

Oshiro Ken, Masui Toshihiko, 2014. "Analysis of the long-term mitigation scenario in Japan considering uncertainty of the low-carbon energy technology availability", J.JSCE, Ser.E, environmental engineering , 70(6), II_207-II_215. (in Japanese)

Nakamura, K. 2007. "Marine Pollution and Prevention & Carbon Dioxide Wastes (Storage)/ Kaiyouboushi-to-nisankatanso-no-haiki (choryu)". Issue brief. Number 586 (2007.5.8). National Diet Library. Available at http://www.ndl.go.jp/jp/diet/publication/issue/0586.pdf.

Streck, C. et al., 2016. "The Paris Agreement: A New Beginning". *Journal for European environmental & planning law*, 13(1): 3-29.

UNFCCC (The United Nations Framework Convention on Climate Change), 2016. "Paris Agreement-Status of Ratification". Available at: http://unfccc.int/paris_agreement/items/9444.php

United Nations Economic Commission for Europe [UNECE] 2016. "CCS in mid-2016: a high-level overview". Version 2, 20 October 2016. Geneva.

Yanagi, Kenichiro., 2011. "Comprehensive study of environmental assessment law", p.105-107, seibunsha. (in Japanese)