出國報告（出國類別：國際會議）

參加 2017 第 19 屆水資源和再生能源發展國際會議（ICWRRED 2017：19th International Conference on Water Resources and Renewable Energy Development）

服務機關：行政院環境保護署
姓名職稱：涂邑靜技正、陳渤丰技士
派赴國家：日本
出國期間：106 年 10 月 8 日至 10 月 12 日
報告日期：106 年 12 月 26 日

摘　　要

第 19 屆水資源和再生能源發展國際會議（ICWRRED 2017： 19th International Conference on Water Resources and Renewable Energy Development）主要針對水資源管理、能源發展、廢水再利用、環境影響評估、永續發展、生物科技…等不同領域之議題，發表相關之研究論文，提供交流管道與經驗分享，並作為發表相關之研究論文平臺，參與人員包括研究機構、學者、業界、公部門…等。本次會議於日本大阪舉行，會議主軸為水資源和能源議題，會議論文可分多項主題，包括水資源利用、能源工程與發展、廢水處理、廢棄物回收利用、生物科技、化學工程、社會科學…等等，投稿文章數共 185 篇。本次參與目的為瞭解國際水資源利用趨勢外，另外亦以電子海報方式，分享我國於查核開發單位是否落實環評承諾，同時促進水資源永續利用之成果。

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壹、出國目的

第 19 屆水資源和再生能源發展國際研討會（ICWRRED 2017： 19th International Conference on Water Resources and Renewable Energy Development）」由世界科學與工程技術學院（World Academy of Science, Engineering and Technology, WASET）主辦，該單位主要針對水資源管理、能源發展、廢水再利用、環境影響評估、永續發展、生物科技…等不同領域之議題，提供交流管道與經驗分享，並作為發表相關之研究論文平臺，參與對象包括研究機構、學者、業界、公部門…等。

本次參與此國際會議目的為瞭解國際水資源利用趨勢外，亦可與其他國家經驗交流，另外以電子海報方式，分享我國於查核開發單位是否落實環評承諾，同時促進水資源永續利用之成果

貳、行程

日期	地點	工作內容
10 月 8 日	臺北至日本大阪	啟程
10 月 9 日	日本（大阪）	研討會（分組論文會議）
10 月 10 日	日本（大阪）	研討會（分組論文會議）
10 月 11 日	日本（大阪）	彙整兩日會議資料
10 月 12 日	日本大阪至臺北	返程

參、會議地點及內容

「第 19 屆水資源和再生能源發展國際會議」於西元 2017 年 10 月 9 日至 10 日於日本大阪 Hyatt Regency Osaka 舉行。

圖一、會議舉辦地點-Hyatt Regency Osaka

圖二、會議舉辦地點-Hyatt Regency Osaka

本次會議包括投稿發表文章數共 185 篇。其會議主軸為水資源與能源議題，會議論文領域包括水資源利用、能源工程與發展、廢水處理、廢棄物回收利用、生物科技、化學工程、社會科學...等（會議論文資料詳如附錄一）。我國除本署派 2 人代表參加外，亦有國內大專院校研究生參與該場會議。

圖三、第 19 屆水資源和再生能源發展國際會議會場

肆、 會議參與情形摘述

一、 本次會議主題與專討論文

本次會議專題研討分為水資源利用、能源工程與發展、廢水處理、廢棄物回收利用、生物科技、化學工程、社會科學等。本署代表優先針對涉環境影響評估及水資源管理之議題等論文探討研讀，以下就各國針對相關議題探討之摘要如下：

（一）水資源評估與耗水系統之控制：以喬治亞（位於西亞）之 Kvemo Kartli 地區為例，其面積約 6.5 萬平方公里；該國因位置及地形關係，其平均可用水量雖較鄰近國家為高，但近年來同樣受到氣候變遷的影響，造成土地沙漠化、淡水資源不足並導致人口流失，對此該研究應用了地理資訊系統（GIS），針對水源、地形、流域、土地植被、土地利用、降雨、溫度、濕度、土壤組成、地質、大氣條件及人類活動等相關項目進行調查，建立 GIS 數據庫後，對於需進一步探討主題進行套疊分析；透過水資源管理，才可合理利用有限的水資源與防止水資源的損失，並幫助行政機關制定經濟與環境兼顧的發展規劃（詳附錄一第 9 頁）。

（二）油氣電力於埃及能源系統之影響與變化：埃及屬中東較發達經濟體之一，其電力來源以火力發電為主，其中火力發電多半為燃油及燃煤為主，而隨著經濟發展能源需求的提高，對於電力的需求也隨之提高，伴隨而來的便是空氣污染物的增加，如懸浮微粒或鉛已大幅超出世界衛生組織所訂之暴露標準。除了空氣污染物的增加外，同時亦有碳排放增加的情形，雖埃及的人均碳排放量仍低於大多數發達國家，但仍是必須面對的課題。因此，該國近年

持續引進新興污染防制技術、提升火力發電天然氣比例與再生能源的使用，以降低碳排放增加的比率，可有助於降低國家的碳排放量與環境負荷（詳附錄一第 43 頁）。

（三）運用評估模式推估氣候變遷對伊拉克地區水資源之影響：伊拉克除北部部分地區為地中海型氣候外，多半為沙漠氣候，因有幼發拉底河和底格里斯河流經，故水資源較其他國家充足；其中 Greater Zab 與 Lesser Zab 為底格里斯河之主要支流，其水資源的運用與管理便會影響底格里斯河之流量；SWAT 模式分析利用土壤、土地利用和管理條件等參數進行，可用於分析不同流域尺度的水文和水質，該研究以此模式分析 Greater Zab 與 Lesser Zab 流域水資源分布與變化，結果均顯示兩地水資源未來預測均呈下降趨勢，由於兩地區水資源本就極為有限，因此必須儘速研擬相關因應對策，進行適當的介入避免水資源的浪費，和積極的行動確保水資源的利用，對於當地長期水資源管理可說是具有相當的效益（詳附錄一第 52 頁）。

（四）菲律賓加萊拉港灣水質和沿海管理評估：該區域因豐富的自然資源成為旅遊區及聯合國教科文組織列入保護區，近年因人口增長、經濟與旅遊業發展導致沿海水質惡化，將持續加劇對生態系統的不利影響，該研究以水質調查、流體力學、海洋資源、社會經濟等主要和次要數據進行分析歸納，得出該地區水質仍符合該國標準，但已有逐漸惡化的情形，並提出 3 項未來加強方式，分別為加強污水處理建設、保護區分區發展及保存規劃，最後是建置沿海資源管理方案，進行綜合性的管理，始可達到永續性的沿

海生態系統（詳附錄一第 107 頁）。

圖四、第 19 屆水資源和再生能源發展國際會議會場

圖五、第 19 屆水資源和再生能源發展國際會議研討情形

二、 本署發表內容

參與本次會議目的係為瞭解國際水資源管理外，亦分享我國致力於要求開發單位落實環評監督，並水資源有效且永續再利用之成果，本署代表以展示電子海報，分享主題為「臺灣環境影響評估制度於用水回收成效之檢討與貢獻」,主要展示本署 105 年度執行需依據環評承諾進行用水回收之 9 個工業區「環評開發案廢水及用水回收率查核專案計畫」查核成果，內容如下：

(一)Introduction －台灣因先天自然環境及人為影響下,水資源不足已是極需面對之重要課題，目前已逐漸完備水資源保護與水回收再生利用等法規制定，但卻無具體查核水回收執行成效的方式，本研究針對通過環評之工業區作為對象，建構查核制度及精進查核作為，以達水資源永續使用之目的。

(二)Methodologies －台灣的環境影響評估制度於 1994 年建立，部分開發案於環評審查時會要求一定比率之用水回收標準，以達水資源有效利用；其中鑒於工業區進駐廠商特性不同，其用水特性亦包羅萬象，為了有效掌握工業區廢水及用水回收率環評承諾的執行情形，我們邀請相關領域之專家學者及相關機關共同討論以律定查核計畫及方針，召開查核作業研商會議，訂定公版用水平衡圖及回收參數以有效執行查核。

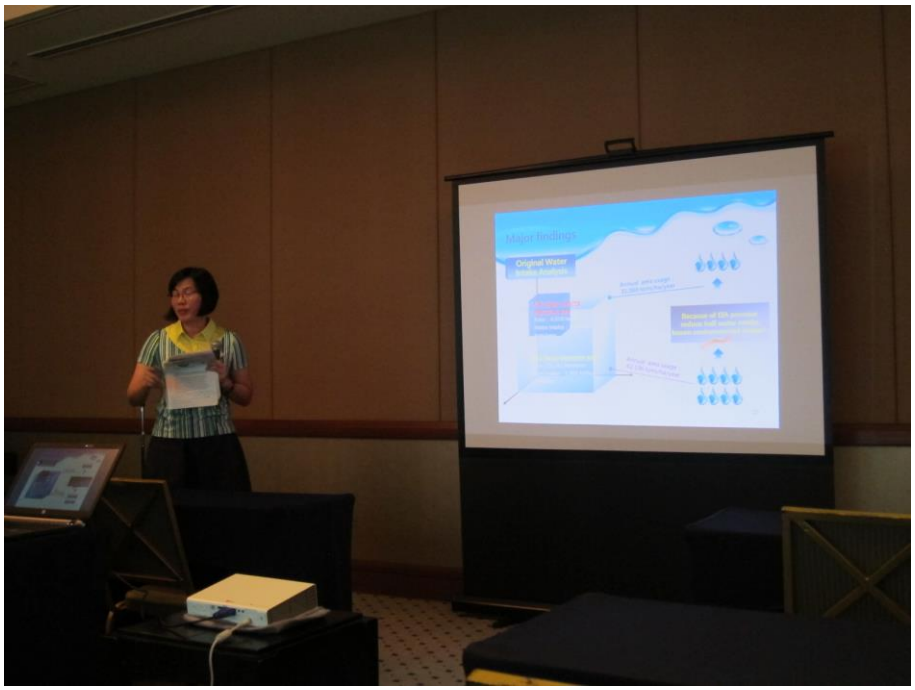
(三)Major findings －本計畫選擇了於環境影響評估審查階段要求一定回收水比率的 9 個工業區進行查核，並針對各工業區內廠商用水量高低分別執行現場查核及書面查核作業，總共查核計 340 家，其執行成效結果顯著；每年節省用水總量約 12.6 億噸，足供

台灣民眾 7 個月用水或灌溉 12.6 萬公頃稻田，另所查工業區平均單位面積年用水量為 31000 公噸/公頃/年，為台灣工業平均用水量的一半，顯見賦予環評承諾的工業區的確可有效降低水資源之消耗。

(四)Conclusions -臺灣環境影響評估制度於制定時納入了後端追蹤查核的特性，本研究其結果顯示了落實環評承諾納入用水回收對於節省水資源使用之重要性，促使開發單位遵守環評承諾，尋找環保及經濟發展的平衡點，亦顯示出環評制度對於環境保護之價值。

本署代表於會中展示本署 105 年度執行需依據環評承諾進行用水回收之 9 個工業區「環評開發案廢水及用水回收率查核專案計畫」查核成果，結果顯示 9 個工業區於用水回收項目執行成效均達到環評承諾之規範，且因開發單位具需符合環評承諾回收率之責任與義務，回收水源亦可使外部水源的需求減少，故其所使用之平均用水量僅為全國工業用地平均用水量之一半，除了符合法規規定外，亦可減輕開發行為對環境造成的影響，顯見落實環評承諾對於珍惜水資源具有相當成效，對水資源之永續發展亦有正面效益。當日現場依據會議流程，以口頭說明及電子海報方式說明本署執行成果約 5 分鐘，會議參與者對於我國致力於經濟與環保的均衡發展表示贊同與肯定。

圖六、本署代表參加第 19 屆水資源和再生能源發展國際會議



圖七、本署代表參加第 19 屆水資源和再生能源發展國際會議

伍、心得及建議

(一) 本次會議主軸主要聚焦在水資源與能源議題，藉由參與會議，可由各國研究者所提出之研究領域成果、環境問題的管理與分析、初步的解決方案，可瞭解各國趨勢與發展現況。目前水資源為有限之資源已是全球共識，因此如何有效整合民間、企業與官方資源，共同創造水資源之永續性使用，為目前應積極研析之方向。

(二) 臺灣年平均降雨量約 2,500 毫米，較世界平均值高約 2.6 倍，但降雨時空分布不均，加上地勢陡峭，河川源短流急，水資源不易儲存利用；又因經濟發展，工商業發展迅速，工業用水逐年成長，所排廢水亦造成水污染問題，並降低可用水資源供應量，可謂「水多成澇，水少成旱，水髒成痾」；再者因目前水價偏低，導致企業在投資時不見得會採用省水技術或水回收設備，更加重水資源的消耗；因此，臺灣在先天條件與人為因素的雙重影響下，水資源的管理已成為一大課題，其並非政府單方面應對可有效處理之情形，而是全民必須共同面對的問題。

(三) 臺灣高科技產業遠近馳名，其具有群聚及轉型速度快的特性，土地利用與社會經濟環境也快速的變化，亦造成了用水需求的快速增長，缺水的風險亦逐步加劇；臺灣產業界近日提出有「五缺」(缺水、缺電、缺工、缺地、缺人才)導致不利投資之環境急需解決；因此自源頭節省寶貴的水資源外，仍需持續拓展推廣其他水源，即「開源與節流」，方可解決缺水之困境；本署於 105 年執行 9 個工業區「環評開發案廢水及用水回收率查核專案計畫」之查核成果，可發現開發單位為符合環評承諾，需採取加強用水量

節省與循環使用的「節流」措施，配合使用再生水、雨水等等的「開源」方式，「節流」與「開源」雙管齊下進行水資源管理與利用，顯示環評承諾對於水資源管理之重要性，亦顯示出環評制度於環境保護的價值，並可追求經濟與環境的永續發展。

(四) 本署於 106 年 9 月 20 日已預告「環境影響評估法」修正草案，本次修正重點包括強化政策環境影響評估功能、增進目的事業主管機關角色功能、明定環境影響評估書件補正及展延規定、重新檢討環境影響評估審查結論效期及開發許可效力、規範開發單位申請變更或廢止審查結論之情形、修訂環境影響評估追蹤監督機制…等，未來於環評監督之內容及方式將有明確且可依循之制度，對於執法上的一致性具有正面的效益。本署可持續精進查核作為，並將執行環評監督之成果及經驗回饋至環評審查端，希冀對持續帶動我國環評制度之進步與完備。

(五) 另外相關查核成果亦回饋水資源管理端即經濟部水利署，因本研究初始查核規劃便是參考該署「用水計畫書審查作業要點」相關名詞定義，然其針對各項循環水量，並無明確計算方式，因此如何確立具體計算標準及可納入計算之標準，以及訂定合理之回收率標準，需經各方面討論後始可成形。本研究成果已多次與該署交流研析，該署並於 106 年 9 月 15 日公告訂定修正「用水計畫書件內容及格式」「用水計畫差異分析報告內容及格式」，明列了各項用水回收項目及水回收率計算方式，因此未來將可更有效推動用水相關管理措施；希冀依相關執行成果，進一步於律定產業合理的用水回收比率與制度持續精進。

附錄一、會議論文資料

Air Dispersion Model for Prediction Fugitive Landfill Gaseous Emission Impact in Ambient Atmosphere

Moustafa Osman Mohammed

Abstract**—**This paper will explore formation of HCl aerosol at atmospheric boundary layers and encourages the uptake of environmental modeling systems (EMSs) as a practice evaluation of gaseous emissions ("framework measures") from small and medium-sized enterprises (SMEs). The conceptual model predicts greenhouse gas emissions to ecological points beyond landfill site operations. It focuses on incorporation traditional knowledge into baseline information for both measurement data and the mathematical results, regarding parameters influence model variable inputs. The paper has simplified parameters of aerosol processes based on the more complex aerosol process computations. The simple model can be implemented to both Gaussian and Eulerian rural dispersion models. Aerosol processes considered in this study were (i) the coagulation of particles, (ii) the condensation and evaporation of organic vapors, and (iii) dry deposition. The chemical transformation of gas-phase compounds is taken into account photochemical formulation with exposure effects according to HCl concentrations as starting point of risk assessment. The discussion set out distinctly aspect of sustainability in reflection inputs, outputs, and modes of impact on the environment. Thereby, models incorporate abiotic and biotic species to broaden the scope of integration for both quantification impact and assessment risks. The later environmental obligations suggest either a recommendation or a decision of what is a legislative should be achieved for mitigation measures of landfill gas (LFG) ultimately.

Keywords**—**Air dispersion model, landfill management, spatial analysis, environmental impact and risk assessment.

I. Introduction

ENVIRONMENT, is a complex subject to model physical, chemical and biological components for interaction practice science to reality [1]. When modeling systems become an obligatory skill in the scientists' kit, decisions will be based upon integration of multidisciplinary data and knowledge, with an ultimate goal of sustainability [2]. The disposal of organic waste at landfill sites generates aerosols by either biological decomposition or particulates coagulation. Both chemical constituents and diffusion mechanism are unconfined flow beyond landfill site unless fumigation from marine boundary layers. Organic vapors are the latter result of either aerobic bacteria or evaporation processes. The contraption of "aerodynamic forces" that cause the removal of aerosols from the surface, is determined by balance of the "wind friction velocity", a measure of wind shear at the surface, with other forces that resist aerosols diffusion such as "gravitational and inter-particle cohesion forces" [3]. The aerosols get entrained into the atmosphere when wind speed exceeds a critical value, that is called the "threshold friction velocity" [4], [5].

The threshold friction velocity is the minimum velocity required to initiate particle motion. The ability of aerosol to disperse and deposit depends on their shape and size [6], with other factors as temperature, moisture and chemical composition affect the coagulation of emitted gaseous [7].

Currently, the existing models can only be utilized for "screening-level" purposes due to the many fundamental over simplifications made, which may seriously compromise the accuracy of the predictions. A wide approach is needed to accurate estimation of source emissions and evaluates the risk posed to either humans or species in the areas near landfill site. Further to design control, air quality model broadens the scope of integration parameters for estimating downwind gaseous dispersion and approach concentration for risk assessment [8].

The United States Environmental Protection Agency (USEPA) has approved a wide range of atmospheric dispersion models [9]. These models can predict concentrations of various pollutants on both local and regional scale; however, most of the well validated models have limitations in estimating concentrations from fugitive dust sources [10]. One of the most commonly used models to compute concentration levels of fugitive gaseous emission is a computerized Gaussian air quality model developed by USEPA [11].

The accuracy of an AQ model depends on the accuracy of the measured input pollutant emission rates [12]. Emission rates can be estimated using data from air quality monitors, or by using empirical emission factors developed by governmental agencies such as, USEPA, 1995 [13] "Emissions Factor" is a representative value or algorithm (for complex cases) that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant

II. Methods for Prediction Impact

The systematic approach of air quality model is broadly an intermediate stage, that based on definitions of quantitative measures between both midpoint abiotic and endpoint biotic

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impact assessment as classified in Fig. 1 [14]. The installation of landfills can pose a range of risks to the ecological receptors and amenity. No matter how the terms are used in recognition ecologic impact when air quality model is predicting environmental impact assessment for possible—positive or negative—processes that intersect to contain entirely natural, social and economic aspects of the ecosystems. The advection of pollutants from unstable marine environment influences dispersion and affect levels of gaseous dispersion. The plume originally emitted into a stable layer in the ambient atmosphere and mixed rapidly to unstable plume in ground level. The accumulation in enclosed spaces above or below ground level, where it could remediate off-site, cause dieback in neighbouring vegetation tissues to increase levels of greenhouse effects. The model is simplified as a central stage median abiotic and biotic endpoint impact assessment as classified in Fig. 1 [14].

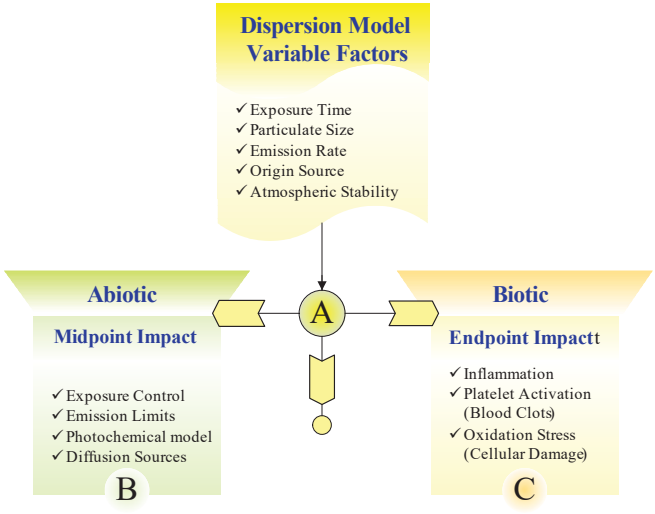

Fig. 1 The Model as central point of EIA policy [14]

A. Approach Analytic Photochemistry

Recently, aerosol processes indicate formation of HCl, as a consequence of sodium chloride photolysis in the presence of methane and carbon dioxide. The polarity of hydrogen chloride molecule makes it very soluble in water and hygroscopic in air to form an aerosol of dense mists or fog by acting as a nucleation center and accreting water from the air. In order to model the behavior of methane, as a simple hydrocarbon with other important reactive components in air, interpretation is based on both equilibrium phase and physical properties of the air flow and the surface. It extends to the chemical contaminants when attributed to the presence of impurities. The formulation of HCl could be a result of the photochemical reaction between methane and chlorine in the presence of ultraviolet light as–typically sunlight. The [Cl^{-}] and [H^{+}] radicals insert into specific chain condition to form internally excited species, and respectively hydrogenation to form hydrogen chloride as an example of a photochemical formation – a reaction simply brought about by light (e.g. [15]).

$$H^{\bullet} + Cl^{\bullet} \longrightarrow HCl$$

Kumar et al. [16] reviewed aerosol microphysics and electrolysis recovery to chlorine species. However, HCl is known as “temporary reservoirs” for chlorine, since active chlorine can be regenerated via both the photochemical and diffusive equilibrium for recovery formulation [17]

$$HCl + OH^{\bullet} + h\nu \longrightarrow H_2O + Cl^{\bullet}$$

$$2\,HCl + CO_2 + h\nu \longrightarrow H_2O + CO + Cl_2$$

The age of the landfill, the type and amount of deposited waste as well natural recovery of environmental equilibrium systems are influence emission rates and hence, fumigation.

B. Experimental Measurement Campaign

Quantitative measurement of aerosols is more difficult and requires collecting the aerosol over a period of time. The capture of hydrogen chloride gas phases requires several minutes or more to collect the sample and therefore does not yield ceiling concentration results. The immediate analysis (by colorimetric tube) or later laboratory analysis can be applied to express HCl values in micron per dry standard cubic meters (µg/dscm), parts per million dry volumes (ppmdv) [18].

EPA (TR-147) method specifies aerosols sample to determine the concentration for HCl present in the raw LFG. The EPA method specified isokinetic samples that withdrawn from gas stream source at the landfill location (i.e. through a glass nozzle, a heated, Teflon lined probe and a heated Teflon filter). Samples have passed through the probe and filter detained in a series of impingers containing a dilute sulfuric acid (H_2SO_4) solution. Dilution enables the use of non-heated transfer lines to deliver a clean, cool gas with low particulate concentration to the ion chromatography (IC) analyzer [19].

OSHA ID-174SG method specifies sample collection with a silica gel tube with glass fiber filter plug for particulate and analysis by ion chromatography, with a recommended sample volume of 7.5 liters collected at a rate of 0.5 liters per minute; this translates to a 15-minute sampling period [20].

The EEAA laboratory specifies a colorimetric tube to indicate airborne measurement of HCl which composed in boundary layer. The measurement systems indicate the formation of HCl in the lower atmospheric layers as a result of active species of high chlorine radicals [Cl^{-}] atom or hydroxyl [OH^{+}] molecules from marine boundary layer [20].

III. Spatial Analysis System Architecture

The advection, transport and deposition nature of atmospheric pollutants has proposed the simulation of air quality models at computer systems. Mostly, data are included in the map layers as attributes for virtualization of physical properties such as point and area sources of pollution, spatial description of terrain elevations, meteorological data, real time air quality monitoring networks and exposure hazards. These require a huge volume of numerical calculations; so that two–dimensional interpolations in the horizontal layers are used to

interpolate three-dimensional atmospheric data as a model grid system, Fig. 2 [21].

In case of large scale air quality modeling, more detailed spatial data are needed to include the endpoint biotic impact of diffusion pollutants in surrounding receptors [22], [23]. Statistical theory is also used to indicate temporal interactions as described by [24]. In spite of air pollutant simulation, air dispersion is carried out by standalone computer systems; the spatial database in the frame of the GIS is used to support more detail virtualization for efficient decision-maker processes.

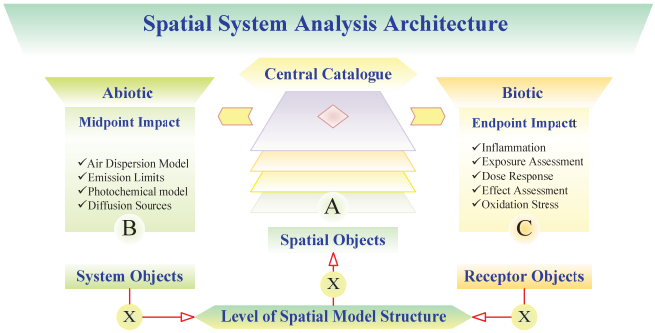

Fig. 2 The Spatial Analysis Model Landfill System Objects [21]

The spatial analysis associated intermediate results of plume dispersion and the potential airborne measurements to be attributed to RDBMS of environmental impact assessment. The concentration reflects health hazardous effects as a biotic endpoint impact assessment. Next section will characterize risk from point's exposure in detail concentration contours levels and model risk assessment of formation HCl aerosols.

A. Equations for Quantitative Assessment

Generally, the most widely used model handle air dispersion phenomenon is based on well-known Gaussian plume formulation. The model uses mass-balance correction factors in order to predict concentrations with improved gradient– transfer deposition algorithms. The model is not designed to handle buoyant sources or any emission in ambient conditions since it does not contain any plume-rise algorithms. The Gaussian plume model used here is the ISCST3 model (Industrial Source Complex, Short-Term, Version 3), and is expressed as [25]:

$$C_{(x,y,z)} = \frac{E_r}{\pi u \sigma_y \sigma_z} \exp\left\{-\frac{1}{2}\left(\frac{y}{\sigma_y}+\frac{z}{\sigma_z}\right)^2\right\} \quad (1)$$

where, C is the concentration averaged over time t (g/m^3); x is the distance downwind in meter; y is the distance crosswind in meter; z is the height above ground level in meter; E_r is the rate of emission from the source (g/sec); σy and σz are the 'dispersion coefficients' representing the crosswind and vertical spread distance of the plume, respectively, which are increasing functions of distance x at averaging time t; and u represents the vertically and time averaged wind speed.

B. Determination of Diffusion Coefficients

Atmospheric temperature and pressure influence the buoyancy of air parcels, when parcel raise to extend diffusion and influence area according to the temperature of the surrounding air. As long as the parcel's temperature is greater, it will rise; as long as the parcel's temperature is cooler, it will descend. When the temperatures of the parcel and the surrounding air are the same, the parcel will neither rise nor descend unless influenced by wind flow.

Scheme for determining diffusion coefficients, based on categories of atmospheric stability class, are developed by many individuals. The commonly used in Gaussian Plume model is based on Passquill – Gifford as attributed according to site conditions [26].

In approach requirement solution, a number of assumptions have been used to approximate coefficients of various atmospheric conditions. The equation in case of area source of fugitive gaseous emission is simplified as a guideline to be comparable between field measurements or modeling framework as [27]:

$$\sigma_y = cx^d \quad (2)$$

$$\sigma_z = a\,x^b \quad (3)$$

where, *x* is the downwind distance from the origin source in meters. The values for a, b, c, and d are taken according to field measurements as parcel advection and diffusion in atmospheric layers.

TABLE I
POWER LAW EXPONENTS AND COEFFICIENTS FOR σz [25]

Atmospheric Stability Class	Passquill Gifford	Downwind Distance meters					
		100 < x ≤ 500		500 < x ≤ 5000		x > 5000	
		a	b	a	b	a	b
Extremely unstable	A	0.0383	1.2811	0.0002539	2.089	0.00025	2.089
Unstable	B	0.1393	0.9457	0.04936	1.114	0.04936	1.114
Slightly unstable	C	0.1120	0.9100	0.1014	0.926	0.1154	0.9109
Neutral	D	0.0856	0.8650	0.2591	0.6869	0.7368	0.5642
Slightly stable	E	0.0818	0.8155	0.2527	0.6341	1.297	0.4421
Stable	F	0.1094	0.7657	0.2452	0.6358	0.9204	0.4805
Extremely stable	G	0.06645	0.8060	0.1930	0.6075	1.505	0.3662

TABLE II
POWER LAW EXPONENTS AND COEFFICIENTS FOR σy [25]

Atmospheric Stability Class	Passquill Gifford	Downwind Distance meters			
		x < 10000		x ≥ 10000	
		c	d	c	d
Extremely unstable	A	0.495	0.873	0.606	0.851
Unstable	B	0.310	0.897	0.523	0.840
Slightly unstable	C	0.197	0.908	0.285	0.867
Neutral	D	0.122	0.916	0.193	0.865
Slightly stable	E	0.0934	0.912	0.141	0.865
Stable	F	0.0625	0.911	0.081	0.884
Extremely stable	G	0.0468	0.986	0.072	0.896

C. Wind Speed Correction

In the lower layers of the atmosphere, wind speed normally increases with height. Most wind speed measurements of national weather service are taken at a height of 10 meters above the surface and listed as "ground level" wind speeds. The wind speed at fumigation sources has the greatest effect on the plume diffusion. Wind speed may be adjusted to the desired surface boundary layer [28]:

$$\mathbf{u} = \mathbf{u}^{*}\left(\frac{\mathbf{z}}{\mathbf{z_o}}\right)^{\mathbf{p}} \tag{4}$$

where: u_z is the wind speed at height z, u* is the wind speed at anemometer height, z is the desired height z_o is the anemometer height (usually 10 meters) and p is defined constant a function of atmospheric stability condition for both rural and urban areas (Table III).

TABLE III
WIND PROFILE EXPONENT AS A FUNCTION OF ATMOSPHERIC STABILITY CLASS [28]

Stability Condition	Pasquill-Gifford	Rural Exponent	Urban Exponent
Extremely unstable	A	0.07	0.15
Unstable	B	0.07	0.15
Slightly unstable	C	0.10	0.20
Neutral	D	0.15	0.30
Slightly stable	E	0.35	0.30
Stable	F	0.55	0.30
Extremely stable	G	0.66	0.39

IV. MOTIVATION RISK ASSESSMENT

Motivation vulnerability criteria can broaden scope of impact assessment to determine dose levels that result in specific consequences as partial context of biotic endpoint impact. This integration encompasses total surroundings for both physical and societal installation dimensions. Traditional assessment procedures are based on Monte Carlo simulation. However, the steps involved in Risk Assessment1 are (1) Hazard identification, (2) Dose response assessment, (3) Exposure assessment, (4) Risk characterization, and (5) Risk management. The assessment will be limited to define components of exposure dose and its effects. In other words, the assessment is intended to ensure that the general public would not be adversely affected by the composed HCl [29]; [30].

A. Exposure Assessment

The assumption of the exposure point concentrations is ultimately examined through sensitivity analysis. A sensitivity analysis identifies input concentrations variables of the myriad which have the most significant impact on the risk values results. The calculation of administrated dose is summarized in the following generic equation [31]:

$$\mathrm{I} = \frac{\mathrm{C}\times\mathrm{CR}\times\mathrm{EF}\times\mathrm{ED}}{\mathrm{BW}\times\mathrm{AT}} \tag{5}$$

I is the intake (mg/kg of body weight per day); C is concentration at exposure point (e.g., mg/L in water or mg/m^3 in air); CR is the contact rate (e.g., L/day or m^3/day); EF is the exposure frequency (days/years); ED is the exposure duration (years); BW is the body weight (kg); AT is the average time (day).

Equation (5) is typical modified for specific exposure pathway, for the intake dose from inhalation of fugitive gaseous may be calculated as:

For Fugitive Emissions Intake dose

$$\mathrm{I} = \frac{\mathrm{C}\times\mathrm{CR}\times\mathrm{EF}\times\mathrm{ED}\times\mathrm{RR}\times\mathrm{Abs}}{\mathrm{BW}\times\mathrm{AT}} \tag{6}$$

RR is the retention rate (decimal fraction); Abs is the absorption into bloodstream (decimal friction).

The concentration in the air is determined as a partial ratio which explored by

$$\mathrm{C} = \mathrm{C_s} \times \mathrm{P_c} \tag{7}$$

Cs is the concentration of chemical in fugitive dust (mg/mg); Pc is the concentration of fugitive gaseous in air (mg/m^3).

Appropriate parameters may be considered for professional judgment such as the exposure frequency and duration rate

B. Effect Assessment

The biotic endpoint impact requires setting a lethal dose, in possible cause damage for 3% fatality, as stipulated by the hazardous installation control rules [32]. Probit equation is the most common expression of acute/lethal dose-response relationship in safety risk assessment [33].

$$\mathrm{P_r} = \mathrm{k_1} + \mathrm{k_2}\ln(\mathrm{C^n}\times\mathrm{t}) \tag{8}$$

C is the hazard concentration (ppm); t is the time in minutes; k1, k2, n are constant relative to type of chemical (a).

The probit constants have been examined by various sources including "Green Book" [34] as listed and there are significant variations in the effects of dose values in Probit equation as expressed hazard. The CPD (Green Book) parameters in probit equations for lethality of hydrogen chloride are taken as k1 = - 6.7 (mg/m^3), k2 = 1 (mg/m^3), n=1 (min) [35].

C. Risk Characterization

The assessment of threats is integrating the effect of four interrelated tasks define of: Potential receptors population;

toxicity assessment; evaluation of potential exposure; risk characterization. The model focused mainly on hydrogen chloride (HCL), which is non-carcinogenic chemical as per United States Environmental Protection Agency classification [31]. However, the limitation of relative criteria responsible to normally characterized risk in terms of a hazard index. This hazard index is simply the ratio of estimated intake dose from exposure to the reference concentration (RfC):

$$HI = \frac{I_c}{RfC} \quad (9)$$

HI is the hazard index (dimensionless); Ic is the chronic day intake of carcinogen (mg/kg.day); RfC is reference concentration (mg/kg.day)

If the acceptable level of intake is deemed to equal the reference dose, then by definition, the hazard index less than 1.0 is acceptable. The EPA's Integrated Risk Information System (IRIS), lists all the RfC's established, and discusses the UF's used in their determination. The toxicologic index in the IRIS database are updated continuously and available at: *www.epa.gov/iris* [36].

V. Results and Discussion

A few scenarios are established to integrate air quality models into the GIS. The basic level is represented by the standalone software application for simulation of air quality models (ISCST3, ISCPRIME), which is accompanied by data inputs and outputs. All data can be used independently by other software systems (GIS, RDBMS, Surfer®, MS Excel® and WWW–presentations). The individual programs form heterogeneous data structures that require the transport of data into various data formats.

The limitations of available data impose a preliminary estimation of initial emission rate, expressed as hydrogen chloride at regulatory default value (10) g/sec. The observation of uncovered hydrogen chloride reflects an increase in landfill boundary layer (LBL) in frequently managed operations as concentration level (43 ppm) and extends to disperse at long distance up to 2 km downwind direction from centerline of landfill area. Fig. 4 illustrates contour lines of HCl concentrations as final result of transformation scenario for virtual output steps carried out during the simulation of air quality models in landfill site.

The model is simplified to determine a non-dimensional concentration $C(x, y, z)$ at specified points downwind as area source. The source is centred on the origin to specify contamination diameter by its width Y and depth X in the wind direction (angle θ to the x-axis) as illustrated in Fig. 4. The receptors can be specified, at any point by a lateral distance y and longitudinal distance (x) from the centre of the source. Other data required are the aerodynamic roughness height (z_o) and the atmospheric stability class.

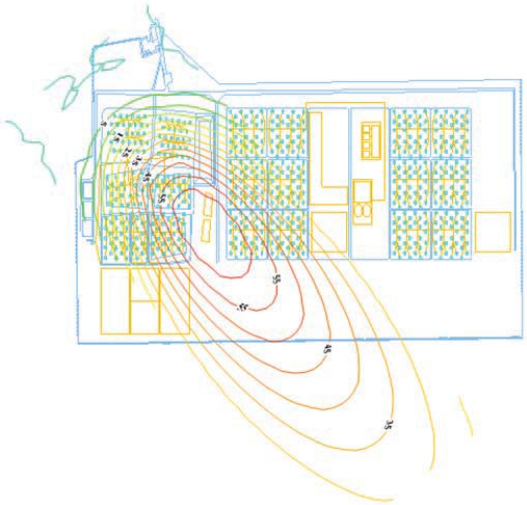

Fig. 3 Contours of HCl concentrations downwind direction

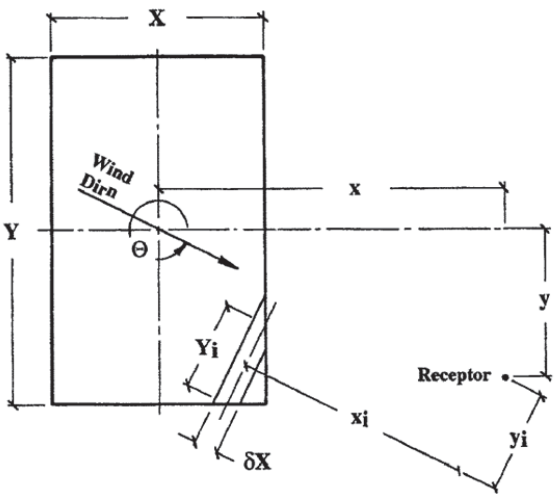

Fig. 4 Sketch defines receptor by its width Y and depth X

The chronic daily inhalation of noncarcinogenic exposure, by adults in residential area, is specified as a function of concentration results of applied air dispersion model. The parameters used for this type of calculation are based assumed exposure conditions (the selected exposure scenario). As an example, the air breathing rate for adults is 0.83 m^3/hr. However, this rate can vary by an order of magnitude from 0.6 m^3/hr at rest to 7.1 m^3/h for vigorous physical exercise. So that CR = 0.83 m^3/h × 24 h/day =19.92 m^3/day; EF = 365 day. For residential exposure, a default value for ED =30 years is typically used [38].

In the absence of better information, a conservative approach would assume the retention rate (RR) and the absorption into bloodstream would be 100 percent or (RR = Abs =1.0); BW = 70 kg: AT = 365 days/year × 30 year = 10,950 days.

$$I = \frac{C \times 19.92 \times 365 \times 30 \times 1.0 \times 1.0}{70 \times 10950}$$

$$\text{Intake Dos } I_c = 0.285 \frac{m^3}{kg\,.\,day} \times C$$

where C is the exposure point concentration (mg/m^3).

The limitation of relative criteria for hydrogen chloride reference concentration makes it hardly to define its RfC in IRIS. So, the worst case scenario is considered and normally characterized for non–carcinogenic as assumed to be equal to:

$$1.00 \times 10^{-2} \frac{mg}{kg\,.day}$$

The average concentration level is measured at receptor point in range (43 ppm ~ 64 mg/m^3):

$$HI = 0.285 \times 64 \times 1.00 \times 10^{-2}$$

$$HI = 10.24 \times 10^{-2} < 1.00$$

The IRIS database contains both qualitative and quantitative data regarding non carcinogens and carcinogens. At present the EPA has defined acceptable risk for carcinogens as within the range of 1×10^{-4} to 1×10^{-6} (one in million) in excess the person's risk of cancer from all source combined over lifetime. As hazard index of noncarcinogen less than 1.0 as defined criteria [37].

VI. Conclusion

The spatial analyses expand our knowledge for virtual interpretation the effect of landfill site as reaction substrates. HCl is one of the major results from emitted gases from incineration municipal and hazardous waste. The measured airborne HCl in landfill site is largely unknown origins, but fugitive gaseous emission contains five fugitive sources associated with the production of carbon dioxide (e.g., biodegradation, volatilization, fugitive dust generation, leaching and combustion), are predicted the ecologic impact of specific landfill site.

The hydrogenation of chlorides reaction resulting from photolysis of sea – salt aerosols in presence of hydroxyl (OH) and other volatile organic compounds (VOC) can produce HCl [39]; [40]. On the other hand, the safety risk assessment is carried out to maintain the balance between efficient land use and adequate protection of the general public against the hazardous installation.

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Assessing Impacts of Climate Change on Rural Water Resources

Ntandoyenkosi Moyo

Abstract—Majority of rural Eastern Cape villages of South Africa households do not have access to safe water supply. Due to changes in climatic conditions for example higher temperatures, these sources become not reliable in supplying adequate and safe water to the population. These rural populations due to the drying up of water resources have to find other alternative ways to get water. Climate change has an impact on the reliability of water resources and this has an impact on rural communities. This study seeks to establish what alternative ways do people use when affected by unfavorable conditions like less rainfall and increased temperatures. The study also seeks to investigate any local and provincial intervention in the provision of water to the village. Interventions can be in the form of programmes or initiatives that involve water supply strategies. The community should participate fully in making sure that their place is serviced. The study will identify households with improved sources (JOJO tanks) and those with unimproved sources (rivers) and investigate what alternatives they resort to when their sources dry up. The study also investigates community views on whether they have any challenges of water supply (reliability and adequacy) as required by section 27(1) (b) of the constitution which states that everyone should have access to safe and clean water.

Keywords—rural water resources, temperature, improved sources, unimproved sources

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Assessment of Water Resources and Inculcation of Controlled Water Consumption System

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***Abstract*—**Deficiency of fresh water is a vital global problem today. It must be taken into consideration that in the nearest future fresh water crisis will become even more acute owing to the global climate warming and fast desertification processes in the world. Georgia has signed the association agreement with Euro Union last year where the priority spheres of cooperation are the management of water resources, development of trans-boundary approach to the problem and active participation in the "Euro Union water initiative" component of "the East Europe, Caucasus and the Central Asia". Fresh water resources are the main natural wealth of Georgia. According to the average water layer height, Georgia is behind such European countries only as Norway, Switzerland and Austria. The annual average water provision of Georgia is 4-8 times higher than in its neighbor countries Armenia and Azerbaijan. Despite abundant water resources in Georgia, there is considerable discrepancy between their volume and use in some regions because of the uneven territorial distribution. In the East Georgia, water supply of the territory and population is four times less than in the West Georgia.

***Keywords*—**GIS, sociological survey, water consumption, water resources.

I. Introduction

THE water crisis is the #1 global risk based on impact to society (as a measure of devastation), as announced by the World Economic Forum in January 2015 [1]. "Food security is also impacted by the decline in water resources. Due to land degradation there is less water and snow being stored in the ground. In 10 years, two out of every three people in the world could be living under stressed water conditions.

"Climate change and unsustainable land use, particularly by agriculture, are contributing to the decline of freshwater resources in all regions of the world. As a consequence, global food production is projected to fall by 2 per cent every decade. A world where all rights to food, water and human security are guaranteed is possible. But we need to change course and start securing every hectare of land that can provide food or freshwater" [2].

There have been 265-recorded incidences of water conflicts from 3000 BC to 2012 [3]. It is now commonly said that future wars in the Middle East are more likely to be fought over water than over oil [4]. Solution of relations regarding water use and water consumption within Georgia and beyond its borders is one of the important guarantees of the regions' stability. The mentioned problem is the urgent one for Georgia as well as the territory of the country comprises of transboundary water bodies and the transit flow consists of 12% of the total flow. It should be taken into account that, due to the global warming and progression of the process of desertification, it is probable that the fresh water crisis will become more and more pressing issue in the near future.

Fresh water resources represent the core natural wealth of Georgia. According to the average height of water layer (760 mm) Georgia lags behind Norway (1190 mm), Sweden (1040 mm) and Austria (800 mm) only. The average annual water provision is $760X10^3$ m³ while the same indicator for the neighboring countries such as Armenia and Azerbaijan is $190X10^3$ m³ and $90X10^3$ m³ respectively (Figs. 1 and 2). Water resources of Georgia are located within the basins of two – Black and Caspian seas. According to the average height of water layer Georgia (760 mm) follows Norway (1190 mm), Switzerland (1040 mm) and Austria (800 mm) among the European countries.

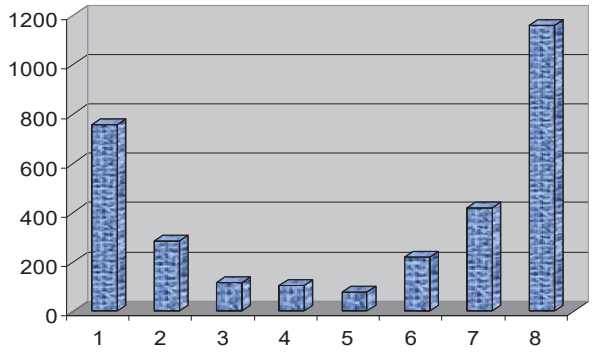

Fig. 1 Water provision by the territory 1-Georgia, 2-Armenia, 3-Azerbaijan, 4-Iran, 5-Irak, 6-Turkey, 7-France, 8-Norway

Georgia strives for deeper cooperation with Euro Union. Among the priority spheres of that cooperation, one of the most important ones is sustainable development of water resources. Water management requires a good understanding of the geographical space and related spatial information such as water sources, terrain surface, watershed, land cover, land use, rainfall, temperature, humidity, soil condition and composition, geology, conditions on the atmosphere, human activities, environmental data, etc. [5]. Inculcation of controlled water consumption system will create better conditions for the rational and more efficient use of the budget expenditures that will have positive effect on economics and social sphere of the country [6].

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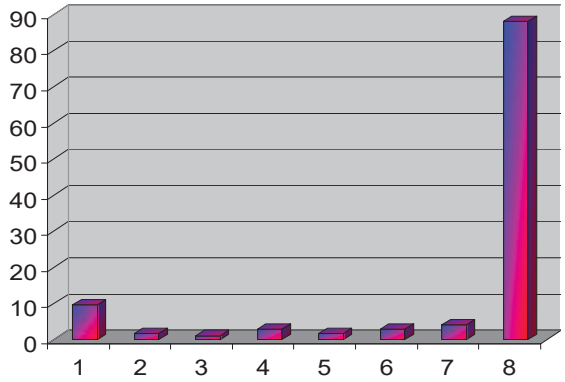

Fig. 2 Water provision by the population 1-Georgia, 2-Armenia, 3-Azerbaijan, 4-Iran, 5-Irak, 6-Turkey, 7-France, 8-Norway

According to the national action plans of Georgia [10], [11] the study region attributed to desertification sensitive territory. The fresh water problem there will become even more acute against a background of the current climatic changes and expected desertification of territories that most probably will cause migration of local population from the region.

II. Study Area and Method

Kvemo Kartli has been taken as the region under study because of the above reasons (Fig. 4). Its area is 6.5 thousand of square km (that is 9.3% of the country territory). There are 347 settlements – 7 cities, 6 towns and 334 villages.

The hydrography network of Kvemo Kartli is represented with trans-boundary river Mtkvari and its tributaries; 15 lakes are used for recreation, irrigation and fishing purposes; 6 reservoirs are used for fresh water supply, power and irrigation purposes. There are mineral, sulphur and thermal springs [12], [13].

Tbilisi -the capital of country is located next to Kvemo Kartli region. The nearby Azerbaijan and Armenia republics, Tbilisi international airport, high level of urbanization, transport and power corridors, etc., favor development of the region. Its natural conditions are most favorable for agricultural purposes with 2-3 harvests per year that stipulate for high competitiveness of the region in comparison with other ones. Different branches of industry such as mining, metallurgy, chemical production of cement and construction materials, ceramics, glass, etc., along with power generation plants are the most active water consumers in the region.

The main problem of nearly all municipalities in the region are irrigation schemes which are depreciated or in poor state today. The existing problems of water supply hinder development of agricultural branches considerably.

Against the current background of global, warming one of the best remedial measures of the said process will be drawing up the water economy balance of river basins and municipalities, assessment of the territory water supply and inculcation of controlled water consumption system in the region [7]-[9].

The GIS for creation of Kvemo Kartli water resources management system will use for the first time instead of the bulky and versatile data available.

The goal of study is to integrate the recent mechanisms compatible with European standards into Georgian water resources management system based on GIS. Moreover, to draw up water economy balance for the purpose of proper determination of water consumption priorities that will be an exchange ratio of water resources and water consumption of the concrete territory.

With that end, in view the region under study subdivided into four units. For all four units held the following activities:

1. **Collected of data and information.** At the initial stage, all available data on water resources and water consumption existing in different institutions of the country gathered.
2. **Created of GIS basis of Kvemo Kartli water resources.** The basis created according to the topographic map of Georgia, scale 1:200 000. Detail lose sheets (scale 1:100 000 and 1:50 000) were issued when required.
3. **Field-expedition works.** The said works arranged in all municipalities with a view to specify data. So, the most recent and real information on the state of water objects, irrigation schemes, etc. obtained.
4. **Sociological inquiries.** The questionnaire worked out with a view to find out the opinion of local population on water consumption issues in the course of field works.
5. **Formed of the bases structure and data loaded into GIS.** The final structure of databases determined after collection, initial processing and analysis of data. The basis transformed according to the design problems and all types of data and information loaded. The obtained information converted to digital format.
6. **Drew up water economy balance of many years for river basins and the separate municipalities.** The data of 2016 on population, irrigation schemes and land use specified by field works used in water economy balance.
7. **Evaluated of the territory provision with water and determine of sensitive territories according to water resources.** Water provision of territory estimated and corresponding map drawn up.
8. **Calculated and mapped of the maximum possible population number calculated per head for different water consumption standards.**
9. **Calculated of water resources and water consumption exchange ratio.**
10. **Exchanged of information on trans-boundary water objects with representatives of organizations dealing with water resources from neighbor countries (Armenia, Azerbaijan, Turkey).**
11. **Prepared of Kvemo Kartli water resources GIS and the program multi-media packet.**
12. **Worked out virtual scenarios of water resources management for training purposes.**

According to the activity 4, sociological survey was implemented in order to assess the water consumption issues that local population face in Tetritskaro (Fig. 3). The main

objectives of the survey were following: 1) Identification of main water maintenance types; 2) Assessing the locals' accessibility to drinking and irrigation water; 3) Evaluating people's general satisfaction with the water supply, it's quality and quantity; 4) Identifying the main issues associated with water consumption.

Considering the goal and the objectives of the study, qualitative research method was used. Survey was conducted using focus group (group discussion) method. Group discussions were organized prior to the survey by key personnel of the project in collaboration with local municipalities. Each focus group consisted of 6-8 locals who were intensively engaged in agricultural activities. A guideline for the group discussions was designed by the key personnel (sociologist) of the project in collaboration the experts from the relevant area of the study. The semi-structured guideline included approximately 15 questions. The focus groups were led by a moderator. In total 4 focus groups will be conducted in Tetritskaro municipality: One focus group was conducted in municipality center and 3 focus groups were conducted in different villages of the municipality. The lengths of the discussions were around 1.5 hours. The focus group discussions were recorded on an audio tape. Recorded group discussions were transcribed. Obtained data was analyzed in the framework of code categories developed based on transcripts. Survey followed all ethical standards of the social research. The study shows that only some of the settlements of the municipality have integrated water supply system.

Fig. 3 Sociological Survey in Tetritskaro Municipality

The rest of the locals usually use the underground water as drinking water and the rainwater for agricultural reasons.Tetritskharo water is consumed for irrigation needs by the other municipalities as well, however, the locals emphasize that the received water is not usually enough for irrigation. Locals presume that brurst mains and leaks do happen and this can result in properties suffering from no water or low pressure. They presume that irrigation system is outdated and damaged and needs renovation. Focus group participants also mentioned that the quality of the water is quite low, especially during rainy days.

They also argued the hygiene issues caused by the limited accessibility with integrated sewerage system.

Fig. 4 Study Area

One of the basic conditions for preservation and smooth development of the unique ecological systems in Georgia is elaboration of the united and efficient management system of water resources. The strategy of water resources management means their protection, restoration and rational use first of all.

According to the directives of Euro Union water management/regulation is quite complicated system that must be followed by proper monitoring and executive system. According to Euro Union notion water management is a dynamic process directed to the positive result. Updating of analysis and estimates envisaged in the frame directive on water by Euro Union are made periodically. There are no institutions in Georgia for sustainable management of water resources today. The integrated management of water resources can be initiated with slow steps before creation of corresponding legislation and institutions.

The scientific value and practical realization of the project results are directed to the receipt of real estimate of water resources quantitative characteristics existing in Kvemo Kartli region. The data bases of GIS will be created and subject maps will be drawn up that will help administration bodies to work out plans of regional economic development.

The results of project will help water users to develop tight bonds between industry branches, transparent management of water resources, rational use of water resources and methods against water losses. Moreover, it is important that by means of GIS it will be possible to update data bases along with their analysis.

For proper planning/development of country economics it is necessary to introduce the virtual water as an independent component into water economy balance expression. Virtual water is comparatively new notion. It is a volume of water contained in any product that is necessary for its manufacture. In the outgoing (spending) part of the balance made up by the said method the volume of water needed for manufacture of any product in the region will be envisaged. Thus, realization of the project will create more perfect, realistic and perspective picture of water economy balance and the part played by virtual water there.

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Design of an Innovative Geothermal Heat Pump with a PCM Thermal Storage

Emanuele Bonamente, Andrea Aquino

***Abstract*—** This study presents an innovative design for geothermal heat pumps with the goal of maximizing the system efficiency (COP - Coefficient of Performance), reducing the soil use (e.g. length/depth of geothermal boreholes) and initial investment costs.

Based on experimental data obtained from a two-year monitoring of a working prototype implemented for a commercial building in the city of Perugia, Italy, an upgrade of the system is proposed and the performance is evaluated via CFD simulations.

The prototype was designed to include a thermal heat storage (i.e. water), positioned between the boreholes and the heat pump, acting as a flywheel. Results from the monitoring campaign show that the system is still capable of providing the required heating and cooling energy with a reduced geothermal installation (approx. 30% of the standard length).

In this paper, an optimization of the system is proposed, re-designing the heat storage to include phase change materials (PCMs). Two stacks of PCMs, characterized by melting temperatures equal to those needed to maximize the system COP for heating and cooling, are disposed within the storage. During the working cycle, the latent heat of the PCMs is used to heat (cool) the water used by the heat pump while the boreholes independently cool (heat) the storage. The new storage is approximately 10 times smaller and can be easily placed close to the heat pump in the technical room.

First, a validation of the CFD simulation of the storage is performed against experimental data. The simulation is then used to test possible alternatives of the original design and it is finally exploited to evaluate the PCM-storage performance for two different configurations (i.e. single- and double-loop systems).

***Keywords*—**Geothermal Heat Pump, Phase Change Materials (PCM), Energy Storage

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Development of an Inexpensive Electrocatalytic Energy Material: Cu-Ni-CeO_2 for High Performance Alcoholic Fuel Cell

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***Abstract*—**One of the major research areas is to find an alternative source of energy to fulfill the energy crisis and environmental problems. The Fuel cell is such kind of energy producing unit. Use of fuel cell to produce renewable energy for commercial purpose is limited by the high cost of Pt based electrode material. Development of high energetic as well as inexpensive fuel cell electrode materials is needs of hour to produce clean energy using derive bio-fuel. In this present investigation inexpensive Cu-Ni-CeO_2 electrode material has been synthesized by using pulse current. The surface morphology of the electrode materials are controlled by several deposition parameters to increase the rate of electrochemical oxidation of alcoholic fuel, ethanol. The electrochemical characterization of the developed material was done by Cyclic Voltammetry (CV) and Chronoamperometry (CA) and Electrochemical Impedance Spectroscopy test. It is interesting to find that both these materials have shown high electro catalytic properties in terms of high exchange current density (I_0), low polarization resistance (R_p) and low impedance. It is seen that the addition of CeO_2 to Ni-Cu has outperformed Pt as far as high electro catalytic properties are concerned. The exchange current density on the Cu-Ni-CeO_2 electrode surface for ethanol oxidation is about eight times higher than the same on the Pt surface with much lower polarization resistance than the later. The surface morphology of the electrode materials has been revealed by Field Effect Scanning Electron Microscope (FESEM). It is seen that grains are narrow and sub spherical with 3D surface containing pores in between two elongated grains. XRD study exhibits the presence of Ni and CeO_2 on the Cu surface

***Keywords*—** Electro-catalyst, Alcoholic Fuel, Cyclic Voltammetry, Electrochemical Impedance Spectroscopy, XRD, FESEM

Driving Environmental Quality through Fuel Subsidy Reform in Nigeria

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***Abstract*—**Nigeria as an oil-producing developing country in Africa is one of the many countries that had been subsidizing consumption of fossil fuel. Despite the numerous advantage of this policy ranging from increased energy access, fostering economic and industrial development, protecting the poor households from oil price shocks, political considerations, among others; they have been found to impose economic cost, wasteful, inefficient, create price distortions discourage investment in the energy sector and contribute to environmental pollution. These negative consequences coupled with the fact that the policy had not been very successful at achieving some of its stated objectives, led to a number of organisations and countries such as the Group of 7 (G7), World Bank, International Monetary Fund (IMF), International Energy Agency (IEA), Organisation for Economic Co-operation and Development (OECD), among others call for global effort towards reforming fossil fuel subsidies. This call became necessary in view of seeking ways to harmonise certain existing policies which may by design hamper current effort at tackling environmental concerns such as climate change. This is in addition to driving a green growth strategy and low carbon development in achieving sustainable development. The energy sector is identified to play a vital role.

This study thus investigates the prospects of using fuel subsidy reform as a viable tool in driving an economy that de-emphasizes carbon growth in Nigeria. The method used is the Johansen and Engle-Granger two-step Co-integration procedure in order to investigate the existence or otherwise of a long-run equilibrium relationship for the period 1971 to 2011. Its theoretical framework is rooted in the Environmental Kuznet Curve (EKC) hypothesis. In developing three case scenarios (case of subsidy payment, no subsidy payment and effective subsidy), findings from the study supported evidence of a long run sustainable equilibrium model. Also, estimation results reflected that the first and the second scenario do not significantly influence the indicator of environmental quality. The implication of this is that in reforming fuel subsidy to drive environmental quality for an economy like Nigeria, strong and effective regulatory framework (measure that was interacted with fuel subsidy to yield effective subsidy) is essential.

***Keywords*—**Environmental quality, fuel subsidy, green growth, low carbon growth strategy.

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Environmental Accounting: A Conceptual Study of Indian Context

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***Abstract*—**As the entire world continues its rapid move towards industrialization, it has seriously threatened mankind's ability to maintain an ecological balance. Geographical and natural forces have a significant influence on the location of industries. Industrialization is the foundation stone of the development of any country, while the unplanned industrialization and discharge of waste by industries is the cause of environmental pollution. There is growing degree of awareness and concern globally among nations about environmental degradation or pollution. Environmental resources endowed by the gift of nature and not manmade are invaluable natural resources of a country like India. Any developmental activity is directly related to natural and environmental resources. Economic development without environmental considerations brings about environmental crises and damages the quality of life of present, as well as future generation. As corporate sectors in the global market, especially in India, are becoming anxious about environmental degradation, naturally more and more emphasis will be ascribed to how environment-friendly the outcomes are. Maintaining accounts of such environmental and natural resources in the country has become more urgent. Moreover, international awareness and acceptance of the importance of environmental issues has motivated the development of a branch of accounting called "Environmental Accounting". Environmental accounting attempts to detect and focus the resources consumed and the costs rendered by an industrial unit to the environment. For the sustainable development of mankind, a healthy environment is indispensable. Gradually, therefore, in many countries including India, environment matters are being given top most priority. Accounting and disclosure of environmental matters have been increasingly manifesting as an important dimension of corporate accounting and reporting practices. But, as conventional accounting deals with mainly non-living things, the formulation of valuation, and measurement and accounting techniques for incorporating environment-related matters in the corporate financial statement sometimes creates problems for the accountant. In the light of this situation, the conceptual analysis of the study is concerned with the rationale of environmental accounting on the economy and society as a whole, and focuses the failures of the traditional accounting system. A modest attempt has been made to throw light on the environmental awareness in developing nations like India and discuss the problems associated with the implementation of environmental accounting. The conceptual study also reflects that despite different anomalies, environmental accounting is becoming an increasing important aspect of the accounting agenda within the corporate sector in India. Lastly, a conclusion, along with recommendations, has been given to overcome the situation.

***Keywords*—**Environmental accounting, environmental degradation, environmental management, environmental resources.

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I. Background

MORE recently, the environmental crisis has become a global issue. The concept of sustainable development is gradually becoming popular in many countries of the world, including India, where society feels the prevalent role of ecological requirements for economical development. Accounting is no longer confined to the historical description of financial performances; rather, it is now regarded as one of the most important services of society. The ecological role of corporate sectors responsible for their business activities on the environment is becoming particularly explicit. Along with the finance and production results of business activities, their environmental and social effects are also important. Environmental or natural resources are invaluable and hence there is an urgent need to maintain accounts of such resources, and as a result, a new area of accounting under the heading "Environmental Accounting" has emerged.

II. Meaning of Environmental Accounting

Environmental accounting is entirely an emerging and dynamic concept. Environmental accounting is concerned with the accounting for environment encompassing a business. Environmental accounting attempts to identify and bring to the light the resources exhausted and costs rendered reciprocally to the environment by the business houses. In other words, environmental accounting attempts to make the best possible quantitative assessment of the costs and benefits to an enterprise for activities specifically directed to environmental preservation. Environment brings together all inanimate organism and forces functioning in nature including man. In the McGraw Hill Encyclopedia of Environment Science, the term Environment is defined as the "Sum total of all conditions and influences that affect the development and life of an organism," including man. Thus, environmental accounting refers to the measurement and communication of information about the environmental responsibility performance of an organization to interested parties. It is also popularly referred to as "green accounting" or "eco-accounting". Environmental accounting identifies, measures and communicates environmental related information for economic decision making. In short, it records and summarizes the value of environmental goods and services in monetary terms. This branch of accounting provides organizations with the cost of their products and processes, thus leading to resourceful decisions and sustained profitability.

III. Objective and Methodology

This paper is basically based on concepts. As such, the opinions expressed in this paper are the author's own opinion and the opinion of some reputed authors. This paper throws light on certain fundamental and theoretical aspects of the concept of "Environmental Accounting". It also attempts to examine the drawbacks of the traditional accounting system and importance of environmental accounting today. In light of this, the motivation for this paper is not to seek new solutions to the underlying problems facing environmental accounting, rather it is, however, hoped that some light will be shed on the theoretical development of environmental accounting research. The discussion will hopefully provide insights and a basis from which accountants can test their current practices and seek to foster them in terms of providing a better understanding of the interaction between business and the natural environment. More emphasis is given on environmental accounting and awareness, since this is supposed to be the crying need of the day.

IV. Failures of Conventional Accounting

From the earliest days of modern accounting systems, economists have emphasized the limitations of using monetary transactions to measure total economic activity. Conventional economic accounting is practiced by most of countries in the world, since it supports economic policy in two important directions. Firstly, it provides a summary of measures of a nation's economic performance and also an instant picture of the flow of economic activities [1]. Secondly, changes in the environment and in the natural resources have not been expressly included in economic accounts, particularly because disagreement lies in the ways to measure these changes monetarily and thus, it is still impossible to bring them together with other entries in the accounts. The conventional accounting system does not provide firms with their cost of products and procedures. Identifying undisclosed or misallocated internal and external environmental costs and allocating them to particular products or processes are not done in the system. Thus, effective business decisions and sustained profitability suffers. The conventional accounting system deals with only non-living things and their relevant transactions. But environmental accounting identifies the resources exhausted and costs imposed by a business corporation during its activities. The results achieved without considering the natural resources may give us an ambiguous picture. Recording the benefits and costs rendered by the environment to a business corporation and justifying them are the prime responsibilities of environmental accounting.

V. Rationale of Environmental Accounting

Better insight into the potential benefits of investment and costs related to environmental conversation activities does not only help a company improve its efficiency of activities, but environmental accounting also plays a very vital role in supporting rational decision-making. As a result, environmental accounting helps companies and other organizations boost their public trust and confidence and are associated with receiving a fair assessment. Through environmental accounting, an enterprise can enjoy the following benefits:

i. Environmental accounting encourages consumers and helps them purchase environmentally friendly products, i.e., green products produced by the corporate, and as such, both consumers and corporate benefit.
ii. Corporate sectors can show their commitments towards introduction and change, and thus seem to be responsive to new factors. Countries giving importance to the ecological aspect of activities are becoming more and more popular, particularly in Western countries.
iii. Environmental i.e. natural resources taking place in the production as inputs are revealed in this accounting system. Shadow prices of environmental resources are usually defined as the value added attributable to them in the activities.
iv. Pollution control, as a burning topic of discussion, environmental accounting shows the extent to which pollution has been controlled by the corporate sectors.
v. Environmental accounting is of the utmost importance in answering certain queries, such as the extent of natural resources available in countries, what are the incomes arising out of them, what are the expenses incurred to protect the resources, what is its importance from the view of the nation, and at what values should they be shown in the nation's balance sheet, etc.?
vi. Environmental accounting is beneficial in another sense, which offers an idea about industrial development, a nation's economic progress and social welfare and the fulfillment of responsibility towards society [2].
vii. The current national accounting practice does not duly consider the value of natural resources, and as such, it becomes a complicated issue to measure the inter-relationship between environment and development. Environmental accounting is justified when the arguments related to market, society, etc., are considered.
viii. Environment accounting helps in discharging organizational accountability and increasing environmental transparency. Sustainable development is possible with the help of environmental accounting as it helps include ecological ability of enterprise.
ix. Negotiation between the environment and society is helpful to organizations which seek to strategically manage a new and emerging issue with different categories of users.
x. Corporate sectors may be successful in attracting funds from green individuals and new groups with the help of sustaining an environmentally-friendly green image.
xi. In the global economy there is an existence of a strong environmental lobby against environmentally unfriendly industries. Green reporting can be used to combat effectively all negative public opinions.
xii. A corporate sector can be considered as an enlightened corporate sector if it takes the enlightenment approach of environment accounting and thus increases its image of

awareness to the outside world. Environment accounting expressing the concept of sustainable development is very often used as an efficient tool for improving the management of enterprise.

xiii. Environmental accounting minimizes the risk stemming from the management of product liabilities. A business cannot fully include the necessary environmental changes until and unless accounting and finance do so.

xiv. Environmental accounting improves environmental performance through better management of environmental cost and thus, benefits the natural and human environments.

xv. By minimizing environmental impacts through improved design of products, packages and processes, environmental accounting takes the competitive advantage. Inter and intra firm comparison reveals whether environmental costs are adequate or not.

xvi. Environmental accounting detects that part of the gross domestic product which exhibits the requisite cost to compensate for the negative impact of economic growth.

xvii. Environmental accounting estimates the total expenditure on production or enhancement of the environment. Companies seeking long-term profits are possible only when the ecological aspect in its business strategy and policy is considered.

xviii. Multinational bodies like the IMF, World Bank, UNO, etc., are looking for countries seeking their assistance to meet their environmental requirements.

xix. Environmental accounting reveals true maximum income which accounting can actually consume without exhausting the stock of natural assets.

xx. Government can use the data through the changes in financial budget and by other measures to achieve optimal allocation of scarce resources in the economy of a country.

xxi. Environmental accounting shows unsound production and consumption patterns, misuse and scanty use of resources and assets like water etc.

xxii. Optimal allocation of scarce resources in the economy is possible with the help of environmental accounting.

xxiii. Environmental accounting discloses areas of soil and vegetarian deterioration through building construction in open areas due to increasing population pressures.

xxiv. Comparison with conventional accounting discloses the main reasons for the change in net capital formation and the extent of substantiality of conventional accounting.

xxv. Environmental accounting has proved to be highly essential in measuring a nation's economic development, social welfare, industrial development, pollution control and in satisfying the needs of government, still the system is in its infancy and not all countries have been able to develop such a system [3]. But with the passage of time, the system will gradually develop, research will be undertaken and it will fulfill the needs for which it was originated.

xxvi. Through environmental disclosure practices, a company can show its commitments towards introduction and change, and thus appear to be responsive to new factors.

xxvii. Environmental accounting helps negotiation and establishes the company's relationship with society in general and environmental pressure groups in particular. This helps an organization seeking to strategically manage a new and emerging issue with its stakeholders.

The Environmental Protection Agency (EPA) [4] suggests the following benefits:

i. Impressive decision taking through the application of environmental accounting reduces or eliminates many environmental problems.

ii. Environmental costs and potential savings may be obscured in overheads or overlooked;

iii. Environmental costs can keep its balance by generating revenue through the sale of waste or by-products or recycling them;

iv. The understanding of environmental costs encourages more accurate costing and pricing of products;

v. Competitive advantage with customers resulting from processes, products and services can be demonstrated to be environmentally friendly; and,

vi. Accounting for environmental costs and performances nourishes a company's development and operation for an all-round environmental management system [5].

In the light of evolutionary wisdom it is considered prudent to make an endeavor to incorporate the effect of environmental resources in the entire business functions of a business house. Environmental accounting is an attempt to identify the resources exhausted and the costs imposed on the environment by a business.

Excepting the above, keeping books of accounts and interpreting the results thereof may provide an obscure picture of the business corporation. Hence, every corporate citizen should evaluate a system of accounting to record the benefits and costs rendered by the environment of a corporate and justifying these costs and benefits are large constituents of environmental accounting.

Monetary values for natural resources are not ascertained by demand and supply law, but it can be determined on the basis of a shadow pricing method- a method of ascertaining the value of natural resources from a sample group of persons by using its importance to them and how much they are prepared to pay for them. Whatever they assert, the average of a sample of responses is considered its pricing. The identification of environmental expenses provides a comprehensive picture of the efforts undertaken by a business and other sectors of the economy to safeguard the environment. Very often owing to unrecorded environmental costs and the difficulty in extracting and separating environmental costs, industry data are not usually reliable. Maintaining confidentiality and widely following different accounting systems also make the task very difficult. But still, environmental accounting is highly useful in planning, public resource management, pollution control and for policy analysis.

VI. Procedure for Environmental Accounting and Major Issues and Challenges

i. Profit and Loss Account: All revenue expenditures incurred for the protection of the environment should be debited to this account.
ii. Balance Sheet: All environmental and natural resources consumed by the business should be regarded as environmental assets and it should be the liability of the organization towards society to utilize such assets at maximum possible capacity and at minimum cost without adversely affecting society's interest. Any capital expenditure incurred by the organization should be shown in the balance sheet.
iii. Budgets: The environmental budget should be prepared by the organization to ascertain the amount required for environmental activities. The responsible person should check and verify the actual amount of expenditure spent on environmental activities.
iv. Reporting: The organization should report for environmental activities, the cost imposed by the organization on the environmental benefits served by the business organizations, benefits received from the environment and the costs imposed by the environment. In short, social responsibility of business will be satisfied by the reporting system.

The major burning issues and challenges with regard to environmental accounting include: a. Identification of environmental costs; b. Capitalization of costs; c. Identification of environmental liabilities; and, d. Measurement of liabilities. Different guidelines regarding these issues have been issued by many organizations from time to time, but the guidelines are almost advisory in nature.

VII. Environmental Awareness in India

Public awareness towards the environment has grown tremendously since the '70s, when laws for the protection of the environment were passed. Smt. Indira Gandhi, the then Prime Minister felt the necessity of healthy environment and expressed her strong opinion in favor of the environment at the United Nation's Conference on the human environment in Stockholm, 1972. Since then various laws have been enacted from time to time and India have been facing strong international competition, particularly after the opening of the Indian economy in the early 1990s. The first public announcement with regard to environmental related information from business on a periodic basis was made by the Central Government in 1991. The keeping of accounts and records relating to the environment would be beneficial to deter exploitation of natural resources and prevent their depletion. A flexible approach and flexible framework may be adopted and modified according to national priority. The statistical agency being entrusted to collect and handle data will be able to overcome the difficulties with regard to various degrees and categories of natural and environmental resources and services. The Environmental Reporting Practices of the corporate sectors in India are not satisfactory; very few corporate entities have some mention about the environment in general terms. Most corporate entities have taken reporting on environmental aspects under more statutory obligations and less social responsibility. The provisions about reporting on environment protection are not sufficient to submit true and fair information about the effect of corporate operation on environment. By keeping the global environment in mind, a standard accounting policy for determining the Gross National Product (GNP) with environmental data, like industrially developed and experienced countries, may be formulated by the Government of India. Although the Government has launched different programs to maintain an ecological balance and healthy environment at central and state levels through research and education, still it requires special treatment for determination of GNP, a tool for development of economics of the country. Cost benefit analysis can also to be done carefully. An alternative resource allocation mechanism can also be followed to observe the fate of environmental resources. Developing countries like India should develop the environmental accounting without any loss of natural resources. Although environmental accounting and reporting is voluntary exercise in India, the organizations opting to disclose environmental issues in their statements enjoy various benefits such as improved image of the product or company.

VIII. Problems

Environmental accounting shows the extent of pollution controlled by business entities. Although it has drawn the attention of many countries of the world, the concept of environmental accounting suffers from certain problems viz. poor valuation techniques, partial values, uncertainty in values, changing social values, non-economic values, individual and aggregate values, incremental and relative values, inapplicable assumptions, uncertainty and risk, lack of reliable industry data, etc. The basic financial accounting is concerned with monetary transactions which yields price through the transfer of property rights. As property rights do not exist over environmental goods, financial accountant cannot account for the full cost of production, including cost of consuming essential natural resources. A mismatch is found between accounting information and its application to ecological issues by excluding the environmental aspects in financial accounting, the worst polluting company seems to be the most successful and attracts additional investment from an investing public [6]. Environmental goods can easily be valued with the help of any method viz. the replacement cost method, opportunity cost method, Delphi techniques, etc. Measuring the inter-relationship between environment and development is a complicated issue mainly because the current national accounting does not duly consider the value of natural resources. The problem of environment protection is becoming more and more acute and the necessity for considering the value of services of environmental resources is also increasing day by day. Monetary values assigned to environment goods and services under the shadow pricing process are uncertain and insufficiently quantified. Many conditions and assumptions underlying economic theory are

not met. As International firms are inclined to disclose non-financial information including environmental information they have enhanced expectation from Indian companies to act responsibly towards the environment and be accountable to society beyond the traditional role of providing financial accounts to shareholders. For improving the corporate image relating to socially responsible behavior, it is desirable that an increasing number of Indian companies report their environmental performances and social issues. However, most of the available literature in regard to environmental performance reporting has concentrated on developed countries and little attention has been given to the states of environmental reporting of developing countries. Of late, protection of environment and the potential involvement of accountants is a common subject of discussion among accountants around the world. Accountants are to take a proactive role in the environmental protection process. With the opening of liberalization, free trade makes it possible that the costs of environmental degradation due to industrial activities must be internalized in corporate accounts to the best extent possible. So far, no accounting standard has been issued extensively for accounting treatment of the aforesaid problems. Some guidelines regarding these problems have been issued by many organizations internationally, but these are mostly advisory in nature. Although an increasing number of countries impose requirements on companies to report on their environmental performance, in India, companies are required to prepare a so-called "Green Account". The absence of comprehensive and verifiable information and financial data on environmental performance of companies may induce them to pollute the environment and yet appear more efficient economically than others which incur costs to protect the environment. The economics approach to environmental issues as recorded in some countries, assumes that companies in unscrupulous pursuit of profits can do much social harm and the environment suffers. Hence, there is a need for a meeting point between the corporate objective of profit maximization and the need for environmental management. Discretionary environmental disclosures sometimes suggest that corporations strive to unimaginable control over the preparation and disclosure of social and environmental information. Audited financial statements should contain environmental information. Environmental aspects are so significant to a company that there is a risk for the occurrence of significant misrepresentations or inadequate or incomplete presentation of information within financial statements. In such cases, an auditor must pay due attention to environmental aspects during the course of the audit of financial statements.

IX. Conclusion and Recommendation

The existence for a number of paradigms from which environmental research has been developed has resulted in a lack of cohesion in the expectations and desired outcomes of environmental accounting. Further lack of cohesion seeking explanation about the motivation behind corporate environmental accounting adds fuel to this. It can also be said that, even if the environmental goods and services can be quantified in monetary terms, then also certain questions arise as to how far society will benefit from the effects of environmental accounting? The social values placed on environmental goods and services are changing so fast that estimates are likely to be obsolete before they are available for use. Planning for sustainable development requires an estimate of environmentally adjusted GNP. Most of the application of environmental accounting requires shadow pricing because we cannot establish market values, since the economic goods and services concerned are never traded or because we do not want them to be traded, but we do not want to know what they are worth. However, despite these theoretical irregularities, the slogan for environmental accounting has won perpetual benefit inherent in it. The international awareness and acceptance of the importance of natural and environmental resources has laid to the development of environmental accounting. Valuation of environmental goods and services and incorporation of environmental data into the national and corporate levels suggests different techniques. There is high degree of confusion among accountants about how to fit environmental data into financial statements and the techniques available for valuation are also not free from uncertainty. In different countries, the accounting and disclosure practices in respect of environmental issues have become mandatory. But in many countries, no such mandates have been issued. There is now an urgent need to take steps globally and particularly to formulate the accounting and valuation techniques regarding environmental issues. Mandatory guidelines can be issued in each and every country to incorporate these in the company's annual report, including environment related legislations, as in developed countries [7]. The dedication with which work for the development of environmental accounting is going on will surely lead to environmental accounting occupying a more stable and effective position in the coming future, as it could greatly improve the value of economics as a decision-making tool, particularly in determining national policy. The implementation of environmental accounting is expected to bring about a change in the managerial attitudes and thinking. Despite difficulties associated with environmental accounting, there is much evidence to show that a large number of countries around the world have honestly attempted to pick-up the new challenges and threats. Economic activity should not be guided by "profit motive" alone, but should also include "quality of life" and "ecological balance". The key to sustainable growth, therefore, is not to produce less but to produce efficiently, with the help of adopting a proper environmental accounting system.

A comprehensive plan in connection with applying environmental accounting may be initiated for all types of companies to develop harmonization following accounting policy. Environmental accounting, as a part of social accounting, creates an environmentally consciousness atmosphere in corporate sectors and prepares and publishes environmental balance sheets which would pave the way for the increased earnestness among corporates. Traditionally, many internal environmental costs are unrecognized,

unallocated or unassigned to the activities. It is suggested that companies should fully recognize and control all environmental costs, including the aforesaid costs. A business should internalize these costs by anticipating and managing them. Environmental expenditures must be separated to improve decision making and accountability for environmental responsibilities. Every company should focus and set aside a part of their funds for environmental and ecological balance. Environmental accounting requires comprehension of the business environment, business activities and capabilities and the constraints upon its operations. In the absence of specific guidelines with regard to environmental accounting and reporting techniques, usually social cost is considered as a measure of cost of the resources used by an organization during its activities. Unless comprehensive records for the use of natural resources and environment and their services is maintained, reliable and sustainable development cannot be planned and achieved. To foster, create and encourage greening all over the world nobody can deny social costs alone to atmospheric pollution arising out of the discharge of dangerous affluent and wastes. In the light of evolved wisdom, it is considered essential to make an endeavor to incorporate the effect of environmental resources in the entire business function of a business corporation. The technology is available today to reduce environmental pollution and it must be used to correct the excess ecological brutality and minimize the degree of environmental degradation. Current disclosure practices by most companies in India do not fully reflect the environmental impact of corporate operations. There is a need and challenge for companies to become greener when we are marching towards industrialization and globalization. No company has a secure future unless it is environmentally acceptable. Companies aiming at long-term profits must consider an ecological aspect in its business strategy and policy. The sooner precautions are taken to safeguard them, the better it would be. However in the beginning, developing countries can adopt any method with necessary alterations as experiences are gained and requirements are increased. The Rigveda reflects that the environment is to be valued like parents and loved like children [8]. The last two decades have witnessed a tremendous increase in environmental concerns around the globe. The possible long-term harmful effects of unrestricted and unregulated economic growth demand to preserve the environment for future generations. A few other recommendations are:

i. Statement showing disclosures of the conservation of energy and natural resources and expenditures incurred to protect the environment and for replacing environmental degradation may be developed and shown as an annexure to a Director's Report. Installation of pollution control equipment or use of better technology may be considered as positive contribution. The necessary amendments may be made in the Company's Act to ensure such disclosures.
ii. Necessary changes in the rating guideline may be made as companies contributing to environmental degradation are rated low.
iii. Annexure may be added to a Director's Report with necessary amendment in the Company's Act for development of pollution standards for industries or products vs. actual pollution generation position of the company.
iv. Although efforts are being made to prepare financial statements from the national angle, what is required is the establishment of the framework of environmental accounting in determining the environmental policy at the state and national level where the revenues and costs of natural resources, their estimates, dedication, values and assets must be recorded in books of accounts. With increasing social awareness on the environment, accounting fills an expectation role to measure environmental performance. Environmental awareness provides a dynamic for business reporting its environmental performance. In India, the level of environmental related disclosures in corporate annual reports is not encouraging [9]. On the whole, the status of voluntary of environmental disclosure in the annual reports of the Indian companies is not satisfactory. Rather, it can be termed as poor. There are several reasons for the poor disclosure of environmental information. Lack of awareness or commitment, poor environmental performance, poor enforcement of the environment protection acts, etc., may be responsible to some extent for making companies free from obligation to disclosure of such information. Hence, it can be concluded that the absence of standardized environmental accounting practices and disclosure techniques, both at national and international levels, and their legal enforcement, necessitates the urgent and pressing need to take steps nationally and globally to formulate these techniques and practices in regard to environmental issues.

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Ergonomics Sallow Recharge Well for Sustainable Ground Water Resources

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Abstract—This is the ongoing research started in 2013 with the final aim is to design the recharge wells both for housing and industry for ground water conservation in Bali - Indonesia. The research started in Denpasar Regency, one of the strategic areas in Bali. The research showed that there is some critical area of ground water resources, especially in north and west part of Denpasar Regency. It driven by the rapid increase of the tourism industry which is followed by the high rate of population, change of land use that leads to the decreasing of rain water catchment areas, and less awareness on preserve natural resources, including ground water. Focus Group Discussion concluded that in order to solve the problem of groundwater crisis, requires the contribution of all parties, started from making simple recharge well for housing. Because of the availability of land is limited and expensive, it is necessary to present an ergonomic shallow recharge well in accordance with the ability of the family or community. The ergonomics shallow recharge well is designed based on the data of hydrology and the characteristics of soil. The design is very flexible depending on the availability of land, environmentally friendly, energy efficient, culture-based, and affordable. To meet the recommended standard of ground water quality, then it equipped with a filtration and sedimentation ponds. Before design recharge wells is disseminated to the public, it is necessary to analyze the effectiveness of the wells to harvest and absorb rainwater into the ground.

Keywords—ergonomics, ground water resources, recharge well, sustainable

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Evaluating India's Smart Cities against the Sustainable Development Goals

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***Abstract*—** 17 Sustainable Development Goals were adopted by the world leaders in September 2015 at the United Nations Sustainable Development Summit. These goals were adopted by UN member states to promote prosperity, health and human rights while protecting the planet. Around the same time, the Government of India launched the Smart City Initiative to speed up development of state of the art infrastructure and services in 100 cities with a focus on sustainable and inclusive development. These cities are meant to become role models for other cities in India and promote sustainable regional development. This paper examines goals set under the Smart City Initiative and evaluates them in terms of the Sustainable Development Goals, using case studies of selected Smart Cities in India. The study concludes that most Smart City projects at present actually consist of individual solutions to individual problems identified in a community rather than comprehensive models for complex issues in cities across India. Systematic, logical and comparative analysis of important literature and data has been done, collected from government sources, government papers, research papers by various experts on the topic, and results from some online surveys. Case studies have been used for a graphical analysis highlighting the issues of migration, ecology, economy and social equity in these Smart Cities.

***Keywords*—** housing, migration, Smart Cities, Sustainable Development Goals, urban infrastructure.

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Exploring the Relationship between the Adoption of Environmental Processes, Policies, Techniques and Environmental Operational Performance

Renata Konadu

Abstract—Over the last two decades, the concept of environmental management and its related issues have received increased attention in global discourse and on management research agenda due to climate change and other environmental challenges. To abate and avert these challenges, diverse environmental policies, strategies and practices have been adopted by businesses and economies as a whole. Extant literature has placed much emphasis on whether improved environmental operational performance improves firm performance. However, there is a huge gap in the literature with regards to whether the adoption of environmental management practices and policies has a direct relationship with environmental operational performance (EOP). The current paper is intended to provide a comprehensive perspective of how different aspects of environmental management can relate to firms EOP. Using a panel regression analysis of 149 large listed firms in the UK, the study found evidence of both negative and positive statistically significant link between some Environmental Policies (EP), Environmental Processes (EPR), Environmental Management Systems (EMS) and EOP. The findings suggest that in terms of relating EP, EPR and EMS to Greenhouse Gases (GHGs) emissions for instance, the latter should be viewed separately in Scopes 1, 2 and 3 as developed by GHG protocol. The results have useful implication for policy makers and managers when designing strategies and policies to reduce negative environmental impacts.

Keywords—environmental management, environmental operational performance, GHGs, large listed firms

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First-Principles Calculations of Hydrogen Adsorbed in Multi-layer Graphene

Mohammad Shafiul Alam, Mineo Saito

Abstract—Graphene based materials have attracted much attention because they are candidates for post silicon materials. Since controlling of impurities is necessary to achieve nano device, we study hydrogen impurity in multi-layer graphene. We perform local spin Density approximation (LSDA) in which the plane wave basis set and psedopotential are used. Previously hydrogen monomer and dimer in graphene is well theoretically studied. However, hydrogen on mult-ilayer graphene is still not clear.

By using first-principles electronic structure calculations based on the LSDA within the density functional theory method, we studied hydrogen monomers and dimers in two-layer graphene. We found that the monomers are spin-polarized and have magnetic moment 1 μ_B.. The spin density distribution appears only upper layer. We also found that most stable dimer is much more stable than monomer. In the moststable structures of the dimers in two-layer graphene, the two hydrogen atoms are bonded to the host carbon atoms which are nearest-neighbors. In this case two hydrogen atoms are located on the opposite sides. Whereas, when the two hydrogen atoms are bonded to the same sublattice of the host materials, magnetic moments of 2 μ_B appear in two-layer graphene. We found that when the two hydrogen atoms are bonded to third-nearest-neighbor carbon atoms, the electronic structure is nonmagnetic. We also studied hydrogen monomers and dimers in three-layer graphene. The result is same as that of two-layer graphene. These results are very important in the field of carbon nanomaterials as it is experimentally difficult to show the magnetic state of those materials.

Keywords—First-principles calculations, LSDA, Multi-layer graphene, Nanomaterials.

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Future Optimization of the Xin'anjiang Hydropower

Muhammad Zaman, Guohua Fang, Muhammad Saifullah

***Abstract*—**The presented study emphasizes at an optimal model to compare past and future optimal hydropower generation. In order to get maximum benefits from the Xin'anjiang hydropower station, a mathematical model is developed. Change factor downscaling method has used to downscale future scenarios. A Particle Swarm Optimization (PSO) has purposed and applied at past and future water flow to get the maximum benefits from future water resources in this study. The results revealed that the future hydropower generation is more than the past generation. Results revealed that this proposed model gave different results with different water flow amount. This paper gives us idea that what could we get in the past using optimal method of electricity generation and what can we get in the future using this technique.

***Keywords*—**PSO, future water resources, optimization, Xin'anjiang.

I. Introduction

DUE to climate change, water resources optimal use is becoming important now a day. Allocation and optimal use of water became mathematical based due to complication and the importance of optimal allocation of water[1]. During the 19th century, many programming approaches were used for the reservoir operation.[2-5]. Many water researchers and scientist applied these methods for finding the solution of different problems [6-8]. One of the utmost problematic parts faced in real engineering optimization design is management of constraints [9-11]. Real-life limitation normally presents several nontrivial and nonlinear constraints for the solution of engineering design problems [12]. These Constraints frequently limit the possible solutions.

Due to the difficulty and randomness of constraints, a deterministic solution of the problems is quite tough to find. In recent decades, numerous approaches have been suggested for the treatment of constraints and more than a few evolutionary procedures have been planned for these engineering optimization problems. Lately a new evolutionary technique, named particle swarm optimization (PSO), proposed by Kennedy and Eberhart, has been introduced [13-15]

Xin'anjaing hydropower station Optimization is a complicated problem. This paper focused on the optimal electricity generation using two different waters available scenarios (1970-2010 and 2010-2040). 2010-2040 flow is obtained after calibration and validation of SWAT model after downscaling of future data. This paper discusses how we could get the maximum benefit in the future by using optimal water resources.

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II. Mathematical Model

The mathematical model comprises of the objective function and constraints and take water levels as decision variables and maximizations of the hydropower as objective function. The objective function is:

$$G=\text{Max}=\sum_{n=1}^{I}\sum_{j=1}^{M} A_j q_{jt} H_{jt} \Delta \quad (1)$$

The constraints are given as below

Water balance equation

$$V_{j,t+1} = V_{jt} + \left(Q_{\gamma jt} - Q_{jt}\right)\Delta \quad (2)$$

Reservoirs discharge limits

$$Q_{jt.min} \leq Q_{jt} \leq Q_{jt.max} \quad (3)$$

Reservoir storage volume limits

$$V_{jt.min} \leq V_{jt} \leq V_{jt.max} \quad (4)$$

Hydropower station power generation limits

$$N_{jt.min} N_{jt} \leq N_{jt.max} \quad (5)$$

T total period count within a year, T=12

M total number of reservoirs

A_j Power generation coefficient

G maximum power generation output from hydropower

$Q_{\gamma jt}$ Inflow of reservoir j at time period t, m^3/s

H_{jt} Average head of reservoirs j at time period t, m

$V_{j,t+1}$ Volume of reservoir j at the end of time period t

$Qj_{t.min}$, $Q_{jt.max}$ Minimum and maximum water discharge of reservoir j at time period t, m^3/s

$V_{jt.min}$, $V_{jt.max}$ Minimum and maximum volume of reservoir j at time t

$N_{jt.min}$ Minimum hydropower generation constraint of reservoir j at time period t

$N_{jt.max}$ *Installed plant capacity kW*

III. Particle Swarm Optimization

Particle swarm optimization, developed by Keneddy and Eberhart (1995), has divided into two phases. In initial phase particles are distributed randomly in the search space and during evolutionary phase particles change and adjust their position in search of optima until termination by following the best particles. Suppose particles are distributed in a Z dimensional space with v velocity with position k x= k x1 , k x2 , k x3 ,k xz) with velocity Vx = (Vx1 , Vx2 ,…… Vxz). And the velocity and position after t+1 time is given as:

$$V_x^{t+1} = w * V_x^t + c_1 rand_1(pbest_x - k_x^t) + c_2 rand_2(gbest_x - k_x^t) \quad (6)$$

$$k_x^{t+1} = k_j^t + V_x^{t+1} \quad (7)$$

where $k^{min} < k_x^{t+1} < k^{max}$

where x= (1,2…….population size/swarm),i=number of reproduction steps, V_x^t:^:the speed vector of particle x in the xth reproduction step; w=inertial weight, c_1, c_2::learning rates, , $rand_1, rand_2$: independent random variables from (0,1)

uniformly distributed, $pbest_x$best solution reached by particle x, $gbest_x$:the best solution reached by the swarm.

IV.Change Factor (C.F) Downscaling Method

The change factor method[16, 17] is a bias correction method that is used to reduce bias among observed data and model outputs. The main purpose of the CF is to modify the daily variables in the data series of the precipitation and the temperature of the future periods (2020s, 2050s and 2080s) by adding monthly mean changes to the output of the GCM. The modified daily maximimum and minimum temperatures (Tmax and Tmin) of the future data series can be obtained by adding monthly changes between the base years and the future years of the GCM, while future precipitation can be obtained by multiplying the ratio of the future to the reference year monthly data series with the daily precipitation of the base year.

V.Case Study

The study area, which is the Xin'anjiang watershed, lies between 117038'15''-119031'56'' longitude and 29011'9.9''-30013'49" latitude, as shown in Figure 2. The watershed has an area of about 11675.710 km2. In this watershed are located the Xin'anjiang (29028'38.16 Latitude and 119013'31'' Longitude) hydropower stations. The Xin'anjinag hydropower station is located at the Xin'an River in china with 9 powers generating having a 845,000 kW installed capacity. A Mathematical model has run for monthly inflow data of past (1970-2010) and future (2010-2040),which is obtained from RCP4.5 scenario of CCSM4 model of CMIP5 future data and downscaled using change factor downscaling technique, and calculate the annual energy. Results are shown in figure 3 and given in table 1 results revealed that in the future more water will be available as shown in figure 3 a and b and we can get more electricity if we will use this water optimally. In managing our discharge and water level, we can get maximum benefits from this hydropower station in future.

As shown in figure 3 and given in table 1, we can generate more electricity amount using optimal optimization technique than conventional method. Results revealed that rainy year can generate more electricity amount than dry and average rainfall years because of water availability in rainy year is more than dry and average rainfall years. it can also be seen that in future flow will be increase than past flow in the area. We could generate upto $7.02*10^8$kWh electricity amount using the same past flow by the application of mathematical model and particle swarm optimization technique.

V. CONCLUSION

This paper is a try to get optimal electricity from the Xin'anjaing hydropower station in future using PSO and after developing a mathematical model. Results revealed that for getting maximum benefits, when PSO applied at past and future flows. It showed that electricity generation can be more in future if we use future water optimally. Results revealed that if the future water flow increased as observed here, then we can get more electricity and we can do better planning for the utilization of such electricity using PSO technique. This paper gives us the idea that what could we get in the past using optimal method of electricity generation and what can we get in the future using this technique .This study can be fruitful for the water resource planners in the future to get maximum benefits. However. further study is needed using different other optimization techniques.

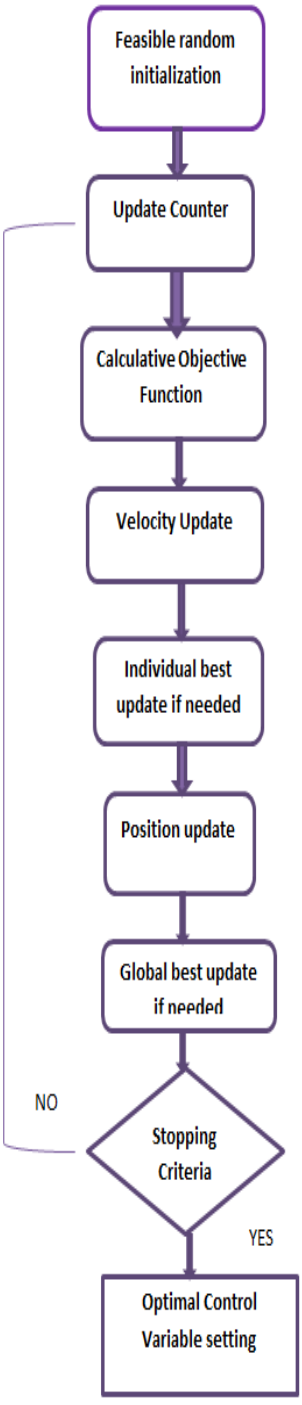


Fig. 1 Schematic diagram of particle swarm optimization algorithm

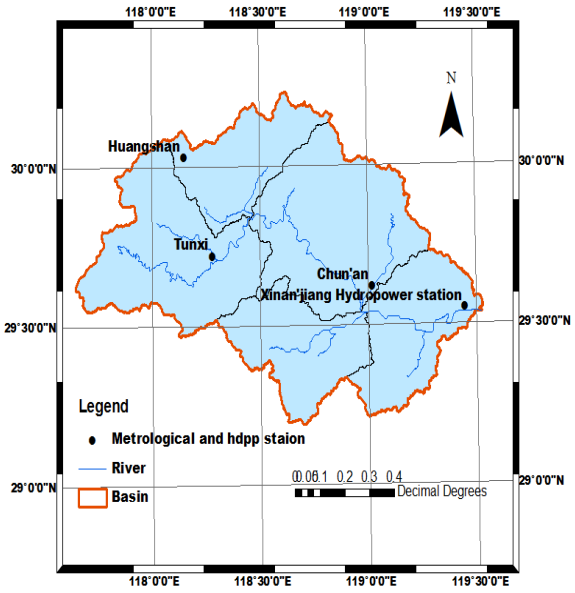
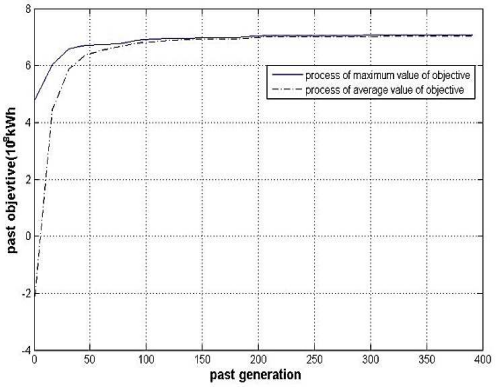
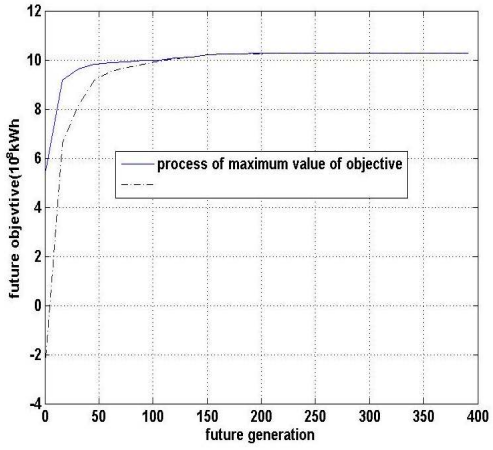


Fig. 2 Study area



(a)



(b)

Fig 3 Electricity generation (a past and b for future) for rainy year of Xin'anjiang reserviour

TABLE I
RESULTS OF DIFFERENT ALGORITHMS

Year	conventional	PSO			
		Past		Future	
	Energy output (10^8kWh)	Execution time(s)	Energy output (10^8kWh)	Execution time(s)	Energy output (10^8kWh)
Rainy year	3.2	2.7	7.02	2.641	10.2
Average year	2.8	2.5	6.02	2.45	9.8
Dry year	2.4	2.4	5.01	2.34	8.6

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Geographic Information Systems and Remotely Sensed Data for the Hydrological Modelling of Mazowe Dam

Ellen Nhedzi Gozo

***Abstract*—**Unavailability of adequate hydro-meteorological data has always limited the analysis and understanding of hydrological behaviour of several dam catchments including Mazowe Dam in Zimbabwe. The problem of insufficient data for Mazowe Dam catchment analysis was solved by extracting catchment characteristics and aerial hydro-meteorological data from ASTER, LANDSAT, Shuttle Radar Topographic Mission (SRTM) remote sensing (RS) images using ILWIS, ArcGIS and ERDAS Imagine geographic information systems (GIS) software. Available observed hydrological as well as meteorological data complemented the use of the remotely sensed information. Ground truth land cover was mapped using a Garmin Etrex global positioning system (GPS) and it was used to validate land cover classification detail that was obtained from remote sensing images. A bathymetry survey was conducted using a SONAR system connected to GPS. Hydrological modelling using the HBV model was then performed to simulate the hydrological process of the catchment in an effort to verify the reliability of the derived parameters. The model output shows a high Nash-Sutcliffe Coefficient that is close to 1 indicating that the parameters derived from remote sensing and GIS can be applied with confidence in the analysis of Mazowe Dam catchment.

***Keywords*—**Geographic information systems, hydrological modelling, remote sensing, water resources management.

I. Introduction

WATER is the lifeblood and a basic need to both the human societies and the natural environment. However, water has become critically scarce in many parts of the world owing to a multitude of driving forces such as the global climate change, pollution and increased consumption levels due to increased demand. As a result, very few issues have now a greater impact on human societies and the biosphere than the planning, development and management of our most important natural resource: water [1].

Water exists on earth through the provisions of the hydrological cycle. Hence, the knowledge of the hydrological processes for a particular place is essential for determining the state of the available water resources of that particular place. The World Bank asserts that, for a country to make sound decisions about water management - especially in the context of investment projects and real time management of the resource at watershed level - a considerable amount of information is required [2]. The prevention of disasters caused by floods and droughts would be virtually impossible without forecasting and prediction of future events. This is only possible with the understanding of the rainfall-runoff phenomenon and with statistical analysis of the past hydrological data, which cannot be achieved without adequate hydrological data. Human activities also have a huge impact on the working of the hydrological cycle, dictating the availability of water. Therefore, planning, development and management of water is highly dependent on the analysis of the existence and distribution of water on a hydrological basis. For the analysis to be executable, a complete set of hydro-meteorological data is required. This then calls for systematic, continuous and repetitive observations, monitoring and assessment of the hydrological stocks and flows. In many cases, inadequate and unreliable data constitutes a serious constraint to developing and implementing water resource management strategies and to manage water effectively.

Mazowe dam was developed to alleviate water scarcity problems in Mazowe Catchment, mainly in the agricultural sector, through the provision of irrigation water amongst other uses. Since its commissioning in 1952, Mazowe dam has been supporting the country's largest citrus plantation. However, from 2001, the dam has been experiencing very low lake levels that have led to an acute decline in the citrus and winter wheat production levels. Given the central role the dam plays in the agricultural productivity of the area, it has invited quite a number of researches to reveal the possible reasons that could have led to its predicament.

Several causes have been attributed to the lake level declines including hydrological and climatic changes [3]. Tererai in 2005, carried out a Mann-Kendall statistical analysis based on rainfall data series from Henderson Meteorological Station and found out that there are no significant trends in the rainfall time series for this station [4]. Viriri and Musariri in 2006 focused on the trends in rainfall, runoff from the gauged streams, releases, water permits, and groundwater abstractions and they owed the reduction of the water levels to the releases that were done in 2002 [3]. However, lack of adequate hydro-meteorological data of the catchment has been the most limiting factor in the analysis of the catchment behaviour

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of Mazowe dam as the climatic data set for Henderson Meteorological Station is incomplete with a lot of missing data.

There exist several methods of hydrometry. However, the collection, storage, analysis and publication of reliable information on both, river discharge and climatic conditions is usually faced with several challenges that often make reliable hydro-climatic data unavailable. These range from lack of observation equipment and infrastructure, the incidences of errors, lack of trained personnel to inaccessibility of some areas in question.

Credit should therefore be given to the rapid development of data acquisition technology such as remote sensing (RS). Remote sensing provides the most efficient and reliable tool to measure, monitor, forecast, and model the spatial and temporal variations of water in the environment in near-real-time [5] and Geographic Information Systems (GIS) allows for the advanced analysis and modelling methods to be implemented in support of water resources efforts. The accumulation and active use of hydrological data in this way plays an extremely important role in watershed management, including flood control, water use and environmental conservation.

This study aims at deriving unavailable hydrological data and catchment characteristics from remote sensing images through the use of appropriate GIS tools. The results of this study will yield important hydrological parameters for Mazowe Dam Catchment that are not available from the ground measurements which when analysed can give insight information about the catchment behaviour in response to different catchment characteristics and the hydrological forcing. The data derived is useful in the analysis of the components of the hydrological processes in this catchment. This information might be very useful to the water managers, decision makers and stakeholders of the water resources in Mazowe dam catchment as possible causes of the dropping water levels in the dam can be identified. Then, appropriate management tools and mitigation measures can be developed.

Mazowe Dam catchment falls in the upper part of Mazowe River Catchment as shown in Fig. 1. The outlet of the catchment at Mazowe dam lies at 17°31'18"S and 30°59'19"E.

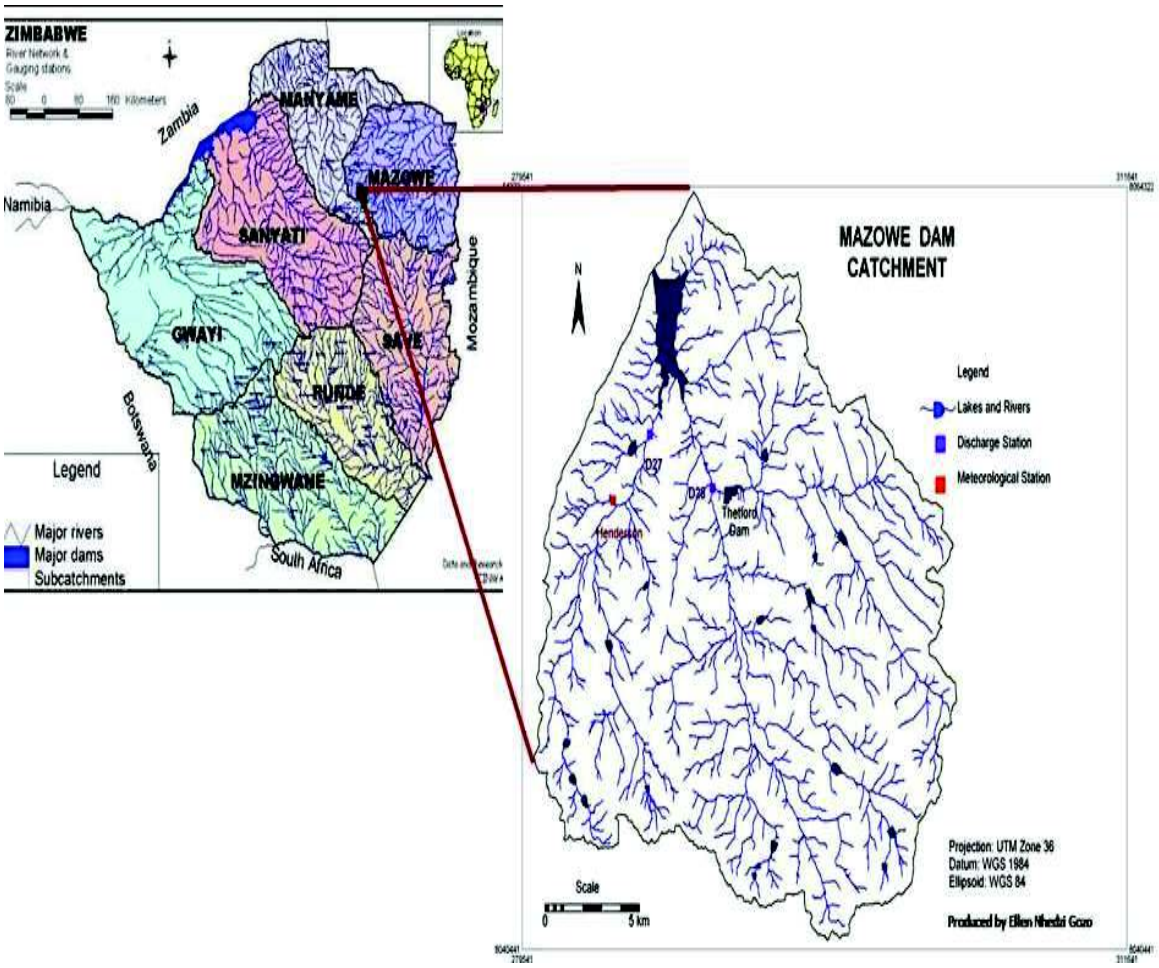


Fig. 1 Study Area Map

II. Application of Remote Sensing and GIS to Mazowe Catchment Hydrology

Remote sensing is the instrumentation, techniques and methods to observe the Earth's surface at a distance and to interpret the images or numerical values obtained in order to acquire meaningful information [6]. Unlike point measurements, remote sensing provides aerial synoptic data. It enables the acquisition of data where ground measurements are impossible, dangerous or highly costly. Where ground observation data is unavailable, information can be derived from images of that particular place that were taken in the past. Remote sensing is also quite useful where repetitive data acquisition is required thereby enabling change detection. With remote sensing, the effect of climate change, population growth and environmental degradation on water resources can be assessed. Flood and drought prediction and forecasting are also made possible with remote sensing. Several platforms and sensors do exist in space gathering information about the earth. These include LANDSAT, SRTM, AVHRR, ASTER, IKONOS, METEOSAT, MODIS and SPOT images among others.

GIS on the other hand is a computerized system that facilitates data entry, data analysis and data presentation especially in cases where geo-referenced data is being dealt with. It provides tools for effective and efficient storage and manipulation of remotely sensed information and other spatial and non-spatial information. Several GIS packages are available for watershed analysis. These include and not limited to ArcGIS, ArcVIEW, ILWIS and ERDAS Imagine. However, these tools provide models of the real world and therefore they need to be verified with ground measurement data.

III. The Study Methodology

The method involved acquiring remote sensing images that capture different catchment characteristics for Mazowe dam that are; the Shuttle Radar Topographic Mission (SRTM), Advanced Space borne Thermal Emission and Reflection radiometer (ASTER) and LANDSAT and the analysis of these images in ArcGIS and ILWIS.

Fieldwork was done to collect waypoints using a Global Positioning System (GPS) (for geo-referencing remote sensing images), hydro - meteorological data, land use and land cover information. Soil sampling was done to determine soil characteristics which include infiltration rate using a double ring infiltrometer, texture and chemical analysis. A Lake bathymetry was also performed using an echo sounder. Soil type distribution, geological and topographical information was obtained from maps.

After having gathered and generated all the data necessary, rainfall – runoff modelling was then performed using the Hydrologiska Byråns Vattenbalans-avdelning (HBV) model to validate the data that was derived from remote sensing and GIS through a comparison of the simulated runoff with observed runoff.

IV. Results and Discussions

A. The Catchment Area Delineation

Mazowe dam catchment was derived from an SRTM digital terrain model (DTM) in ILWIS. To reduce errors, ground control points that were captured during fieldwork were used to georeference the SRTM Digital Elevation Model (DEM). This was then followed by DEM hydro processing in ILWIS to determine flow followed by drainage network and catchment extraction. It was found out that four tributaries drain into Mazowe dam and that there are several small dams upstream of the dam, with the biggest one being the Thetford Farm Dam with a capacity of $1.3*10^6$ m^3. Fig. 2 shows the drainage network of the dam catchment, whilst Table I summarises the attributes of the Mazowe Dam catchment that were extracted from remote sensing data through GIS processing.

TABLE I
Mazowe Dam Catchment Attributes

Catchment Characteristic	Unit	Value
Perimeter	km	93.51
Catchment Area	km^2	341.05
Total Drainage Length	km	656.33
Drainage Density	mkm^{-2}	1924.46
Longest Flow Path (LFP) Length	km	30.08
Longest Drainage Length	km	29.69
Outlet Coordinate	m	(286450.34, 8061663.39)
Outlet Elevation	m	1242
LFP Upstream Elevation	m	1586

A. Climatic Data

Climatic data is available from Henderson Meteorological station

B. Precipitation

Precipitation in the form of rainfall is the main input of water in Mazowe catchment. Knowledge about precipitation is crucial for the catchment management because rain fed agriculture practiced in the area depends on rainfall; droughts and flood hazards are a result of extreme rainfall events; precipitation controls groundwater recharge, irrigation needs, river discharges as well as reservoir intake. The rainfall data is available as a point measurement from Henderson Meteorological station and yet precipitation is areally distributed. Therefore, for catchment analysis, areal distributed rainfall is required. This was derived using the Thiessen polygon method of interpolation available in ILWIS GIS software. This method gives weight to a point in proportion to the space between neighbouring stations. It applies the rainfall at a station to all parts of the catchment area that are nearer to that station than to any other station. Closer to Henderson Meteorological station is Belvedere Meteorological station. As visualised in Fig. 3, the rainfall from Henderson Meteorological station covers the entire catchment.

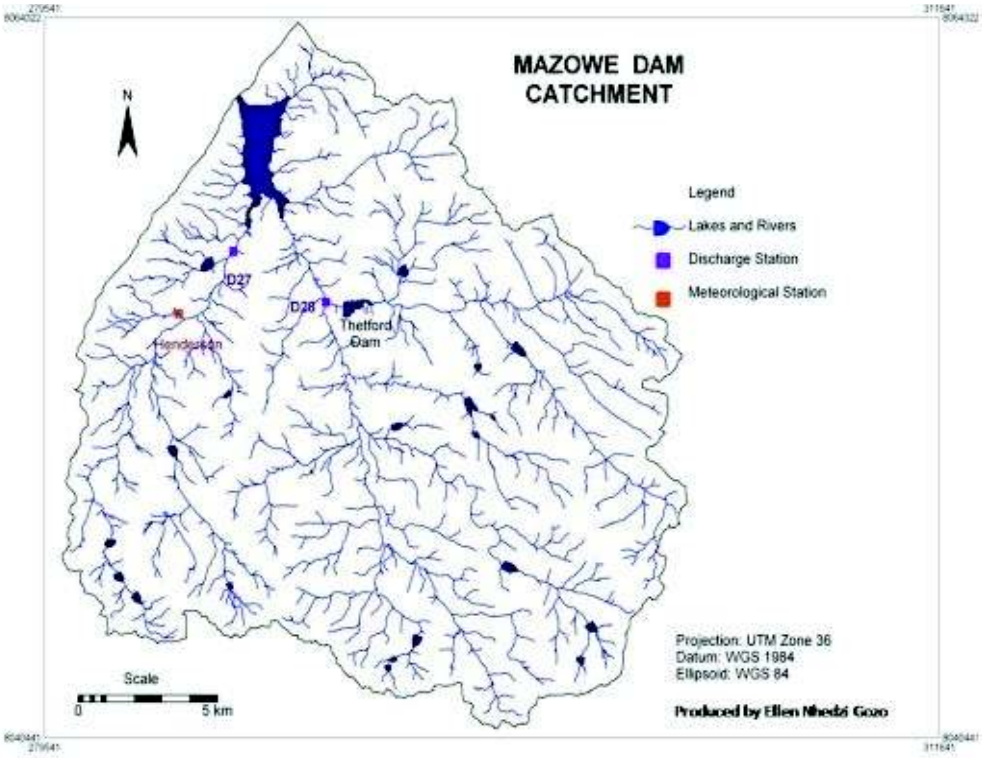


Fig. 2 Map of Mazowe Dam catchment

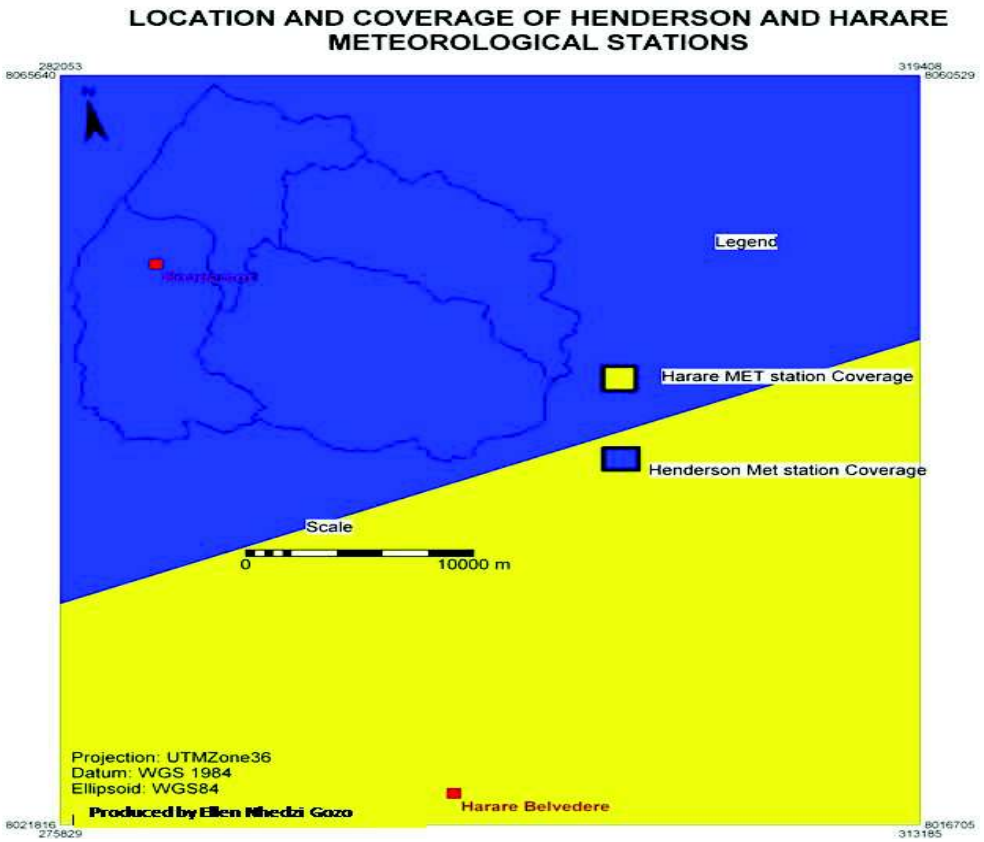


Fig. 3 Thiessen polygons of Harare and Henderson Meteorological (Met) Stations

There are however periods of missing data in the precipitation record for Henderson Meteorological station. Regression statistical analysis was performed for Henderson and Belvedere meteorological stations to determine the relationship between the two. The regression equation was then used to estimate the values for the missing data for Henderson Meteorological station. Daily rainfall records from 1960 to May 2007 were used in the analysis. The annual rainfall for the catchment was found to be 883mm. Fig. 4 shows the long term monthly rainfall distribution in a year for Henderson Meteorological station.

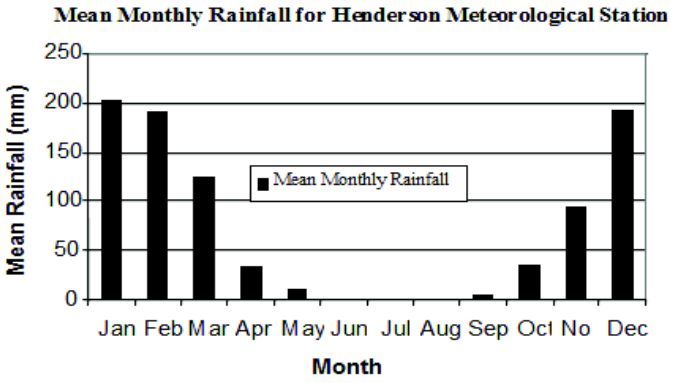


Fig. 4 Monthly rainfall from Henderson station (*Source: Meteorological Services Department of Zimbabwe)*

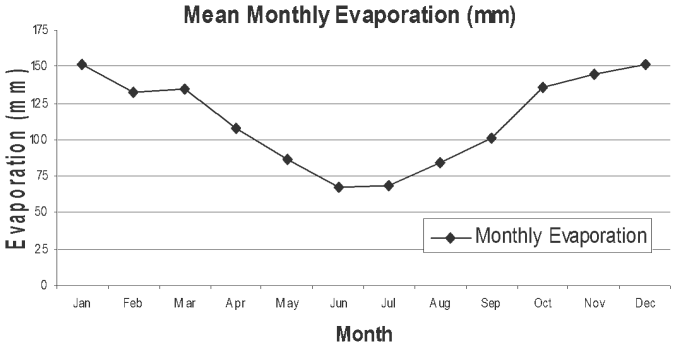


Fig. 5 Mean monthly evapotranspiration for Mazowe Catchment

C. Evapotranspiration

Evapotranspiration information was not available and therefore had to be determined using empirical methods. The Blanney-Criddle method was used to determine evaporation from the catchment because only the daily rainfall, minimum, mean, and maximum temperatures data was available. Fig. 5 shows the mean monthly temperature of the catchment.

D. Soils

Soil information is crucial in catchment management for it determines the infiltration rate and runoff generation of the catchment. The soil information was extracted from a 1:1000000 soil classification map of Zimbabwe. Different soil classes of the catchment were digitized from this map in ILWIS GIS and their distribution within the catchment is shown in Fig. 6. There are mainly three types of soil in the catchment which are locally classified under the Zimbabwean Soil classification system as the Fersiallitic soils (Harare 5E heavy clays), Paraferrallitic (sandy loams) and Lithosols which are sandy loams. Soil sampling was done for verification basing on this soil classification.

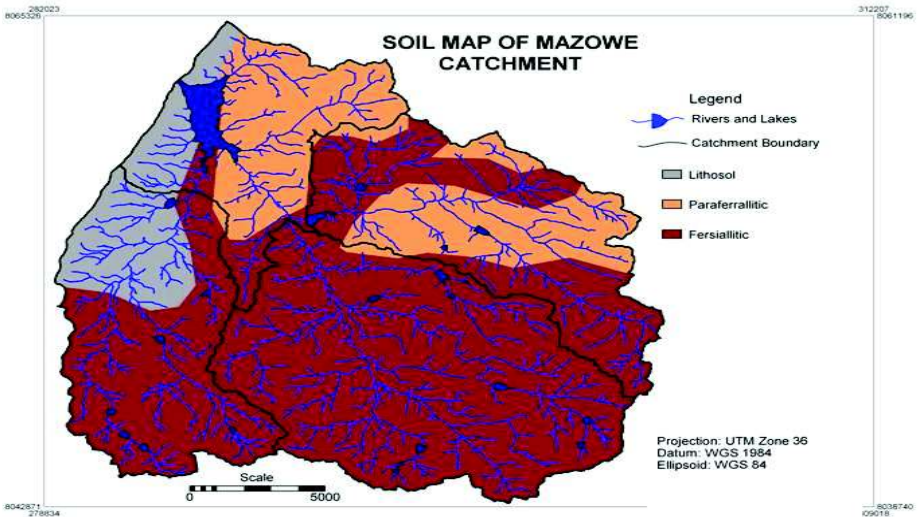


Fig. 6 Soil distribution map of Mazowe catchment

E. Geology and Hydrogeology

The geological information for Mazowe catchment was extracted from a 1:000 000 Geological Map of Zimbabwe (1994) through processing in ILWIS. The catchment is largely underlain by andesitic and dacitic metavolcanics and granitic rocks with a variable potential for groundwater occurrences. The distribution of the parent rock is shown inFig. 7. According to ZINWA's Research and Data section, there is a substantial groundwater utilisation for irrigation in the catchment and borehole yields vary from 10 to 100m^3 per day.

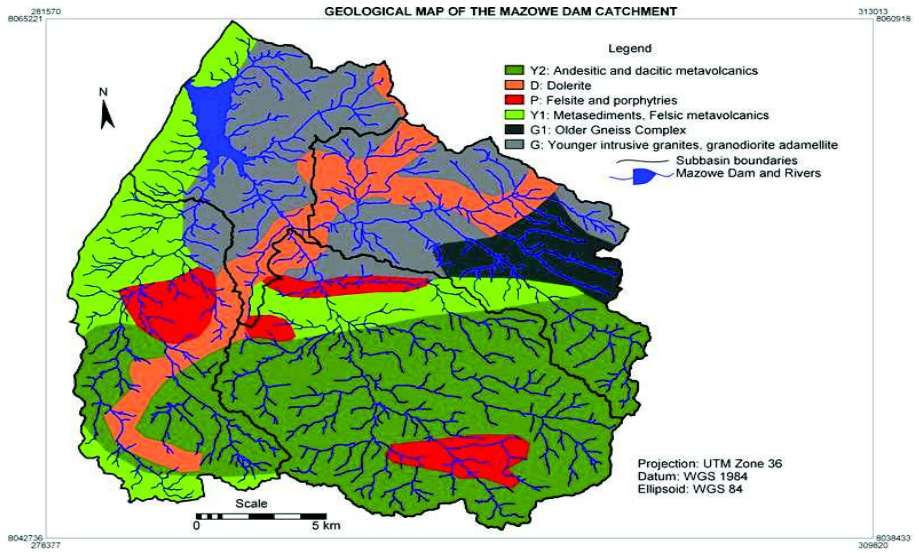
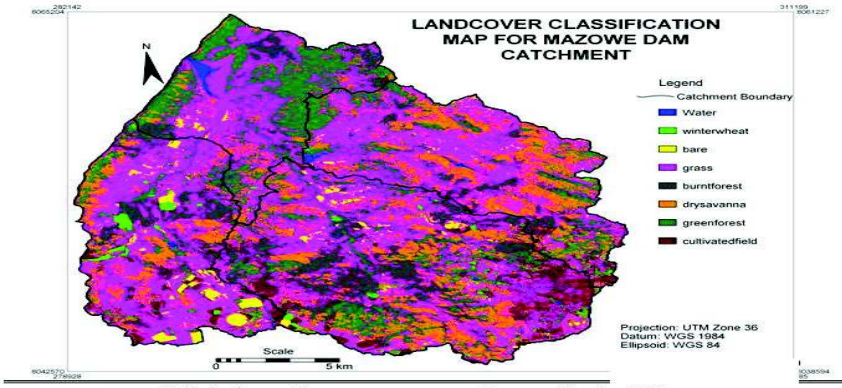


Fig. 7 Geological map of Mazowe Catchment

F. Land Use and Land Cover

The land use and land cover information was obtained an ASTER image of 11 August 2005. The area is mainly under irrigated and rain fed agriculture. Citrus fruits, wheat, maize, soya beans, barley and peas are the main agricultural produces. Some areas are well vegetated with indigenous trees; with the *Brachstegia* species being the dominant tree. Some patches of exotic trees such as gum trees and pine trees are also found in the catchment. To maintain same reflectance, ground truth land cover information was collected during the same month as that of the date when the image was taken.

A supervised land cover classification was performed in ERDAS IMAGINE GIS software. The output of this land cover classification is a land cover class map and a confusion matrix shown in Fig. 8.



Classified Data	Cultivated Field	Dry Savanna	Grass	Green Forest	Burnt forest	Winter Wheat	Bare	Water	Row Total
Cultivated Field	6	0	1	0	0	0	1	0	8
Dry Savanna	2	12	0	0	0	0	2	0	16
Grass	1	3	12	0	3	0	2	0	21
Green Forest	0	2	0	11	2	3	0	0	18
Burnt forest	0	0	2	0	9	0	0	0	11
Winter Wheat	0	0	2	0	0	9	0	0	11
Bare	0	0	1	0	0	0	7	0	8
Water	0	0	0	0	0	0	0	7	7
Column Total	9	17	18	11	14	12	12	7	100

Fig. 8 Land cover class distribution within the Mazowe dam catchment

During fieldwork, eight land cover classes were observed. These are; bare land, water, dry savanna forests, green savanna forests, burnt forests, winter wheat, cultivated fields and grass. An accuracy of 73% was attained. The confusion was seen mostly with green forest and winter wheat.

G. Water Usage in the Catchment

Data on water usage is available in a Water Permit database of the Mazowe Catchment office of Zimbabwe National Water Authority (ZINWA). The water permits are for abstractions from rivers and storage of water in weirs or lakes. Information about real abstractions is not known therefore the amount of water stated on the water permits is assumed to be the real abstractions. Fig. 9 shows the number of permits issued to water users in the Mazowe dam catchment and how much these water permits yield in terms of volume on a yearly basis from 1950 to 2005.

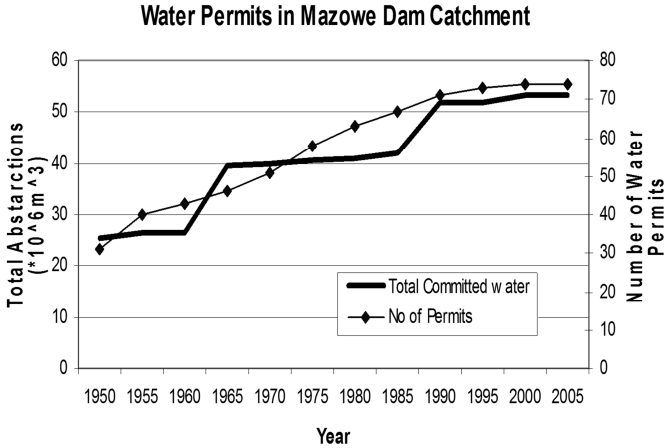


Fig. 9 Water Commitments in Mazowe Catchment. Source: Adapted and modified from Viriri and Musariri (2006)

H. River Discharge

River discharge is measured at two runoff gauging stations; D27 and D28 along Dassura and Mazowe Rivers respectively as shown in Fig. 11. The river flow data is available on daily basis. Fig. 10 shows the annual runoff data for the two rivers.

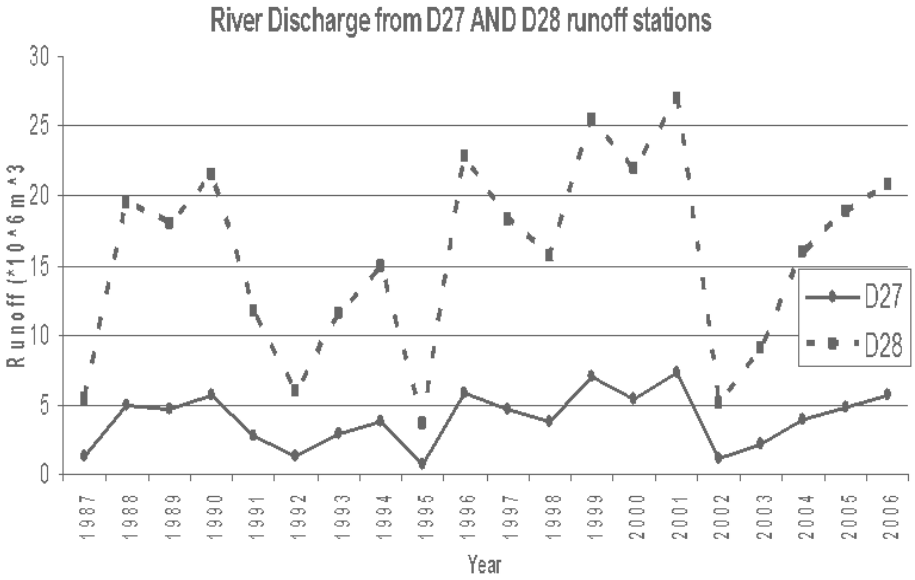
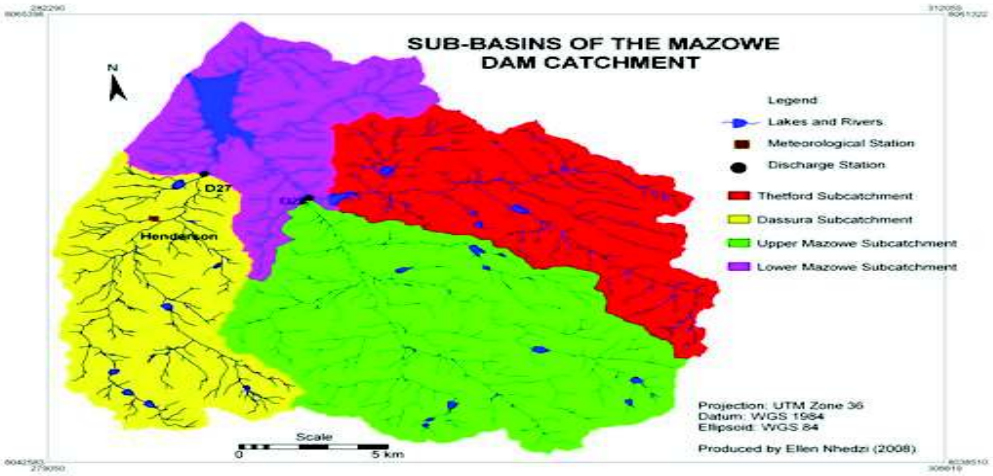


Fig. 10 Annual discharge from D27 AND D28 runoff stations. *Source: ZINWA*

The catchment area was further delineated to enable modelling of the gauged rivers so as to validate the application of remote sensing data in the analysis of this catchment. ILWIS DEM hydro-processing was used to come up with these subbasins. The subbasins created for the modelling process are shown in Fig. 11



Subbasin	Outlet coordinates	Status	Area (km²)
Thetford	(286448.23, 8061666.66)	Ungauged	79.59
Dassura	(286315.12, 8056562.23)	Gauged	76.35
UpperMazowe	(289641.84, 8054881.27)	Gauged	126.28
LowerMazowe	(290247.66, 8054726.34)	Ungauged	58.83

Fig. 11 Showing the four created sub-basins of the Mazowe Dam catchment

A. Lake Bathymetry

Lake bathymetry information is used to determine lake capacities. Bathymetry map generation involves bathymetry acquisition, interpolation and verification of mapping accuracy [7]. The bathymetry data was obtained using an echo sounder system that was developed by Dost and Mannaerts in 2004. This echo sounder system was connected to a Garmin Global Positioning System (GPS) technology to provide geographic data. The outline of the lake was digitised from a LANDSAT TM image of 19 May 1989 in ILWIS. The water level for this day was 99.97m and it was the highest amongst the images whose water levels were recorded. Different interpolation methods available in ILWIS were applied to estimate

values for the missing points. The krigging method was found to be an optimal interpolation method for this lake. Map slicing was then performed in ILWIS to produce a contour map of the Mazowe lake levels and lake volumes were derived in ArcGIS. Fig. 12 shows the lake levels for the Mazowe dam Lake.

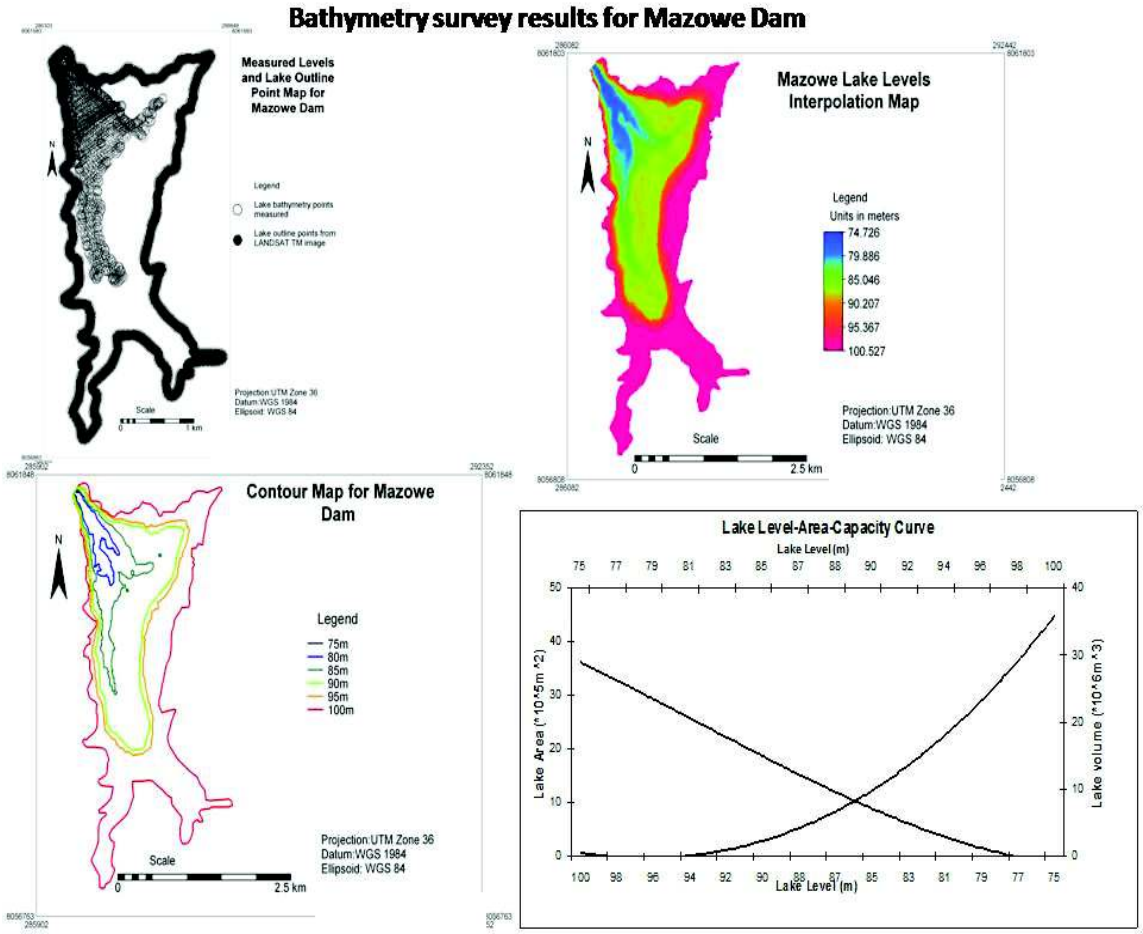


Fig. 12 Bathymetry results for Mazowe Dam

B. Rainfall Runoff Modelling

Rainfall-runoff modelling was performed for the gauged rivers that drain into Mazowe dam using the HBV model. The model was run for a period that covers October 1988 to December 2005. This period had a complete data set for the observed runoff. After running the model with the initial input data, it was observed that the hydrographs of the simulated flows were not matching that of the observed runoff because a hydrologic model is a simplified representation of a complex hydrological system and therefore may not reflect the real world scenario with enough accuracy. A hydrologic model therefore requires calibration of the model parameters to improve the reliability of the model. Calibration was done with ten years of data and optimum parameters were determined. The performance of these parameters was assessed using the objective functions that are available in HBV as well as by visual interpretation of the hydrographs.

Model validation with data from 1999 to 2005 was then performed to demonstrate that the model is capable of making accurate predictions for periods outside the calibration period [8]. Both calibration and validation results show a strong relationship between the simulated and observed runoff from the two gauged catchments as shown in Fig. 13.

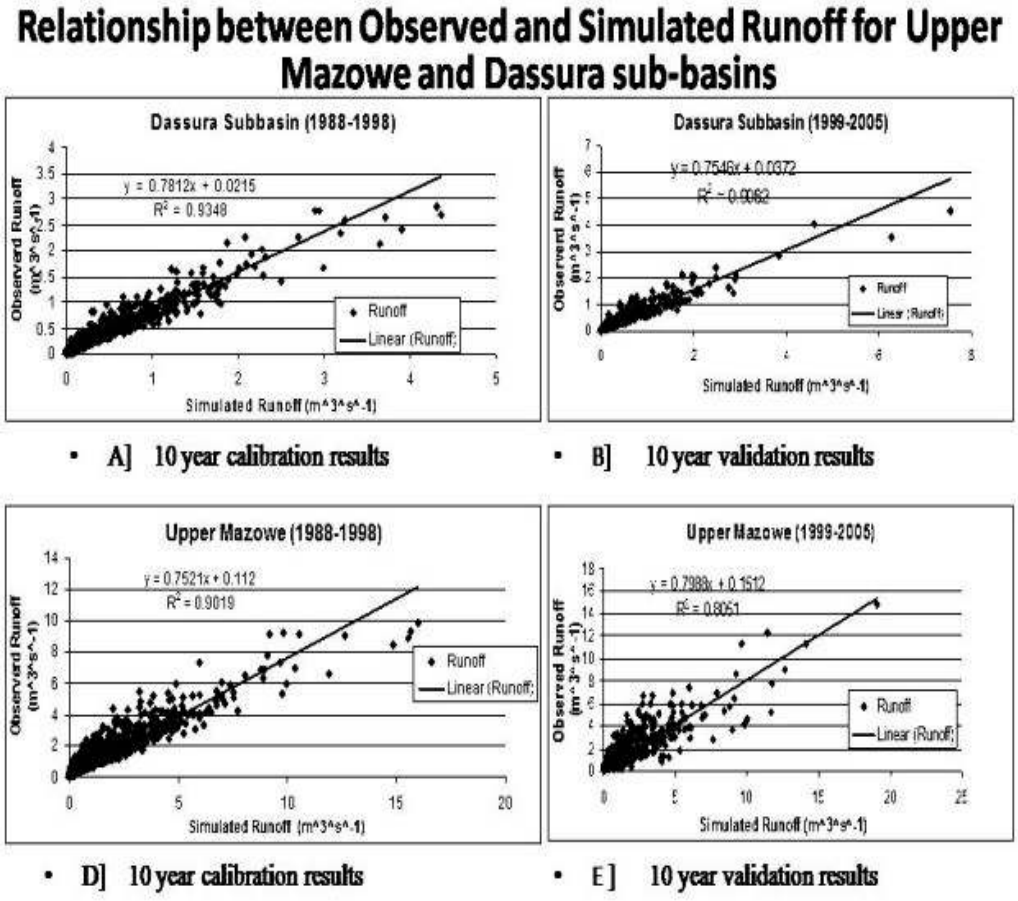


Fig. 13 Calibration and validation results for Dassura and Mazowe sub-catchments

Hence, the modelling process was a success in Mazowe catchment. For illustration, hydrographs for the period 2000 to 2003 for Dassura and Upper Mazowe Subbasins were extracted and are shown in Fig. 14. The results show a very high correlation proving that the parameters for the Mazowe catchment that were derived from remote sensing and GIS can be used successfully in the analysis of the water resources situation in Mazowe Dam catchment.

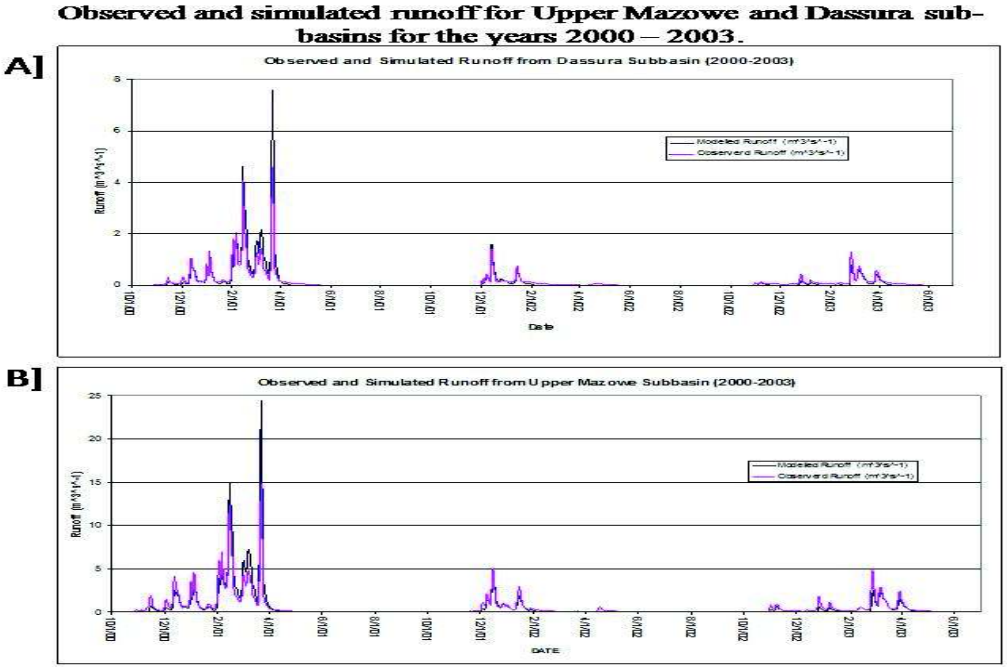


Fig. 14 2000 -2003 hydrographs for Dassura and Upper Mazowe sub-basins

However, the fact that the correlation was close to one and not one, besides the fact that the rainfall and runoff were modelled is because some input data might have brought with them errors as well. Aerial rainfall for the catchment was obtained using a Thiessen polygon interpolation method using rainfall records from one meteorological station hence; overestimation or underestimation of rainfall from one point to the other is most probable. Evapotranspiration was calculated from daily temperatures and therefore errors could have also been encountered during the conversion of water particles into vapour by the formula. This poses a lot of uncertainties because evapotranspiration does not rely only on temperature. It is also a function of other meteorological factors such as wind speed, radiation and vapour pressure. Also, interpolation of this evapotranspiration over the entire area could have also caused some disparities. Finally, maps available for the Mazowe catchment are of a very coarse resolution. The soil map, vegetation map, land use map and geological map are of a 1:000 000 scale which grossly limits detail.

V. CONCLUSION

To overcome the problems of insufficient data for Mazowe dam catchment analysis, information about the land use, land cover, lake bathymetry, catchment outline, river systems and terrain was extracted from remote sensing data using different GIS software. Ground measurement data was also used in conjunction with data obtained from remote sensing. Ground truth land cover information was used to validate land classification information obtained from remote sensing and GIS. Some imperfections were however encountered because the modelling process, remote sensing data acquisition process and input data processing in GIS are prone to simplifications, generalisations, omission of some details and errors. Hence verification with the conditions in the field was crucial and helped in fine tuning the results. Also use of point data which is manifested with gaps should be avoided. Hence, it is recommended that other methods of aerial rainfall, evaporation and soil moisture estimation should be tried in the catchment such as the use of Tropical Rainfall Measuring Mission (TRMM) rainfall products for precipitation and determination of evaporation and soil moisture from remote sensing data.

ACKNOWLEDGEMENTS

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Groundwater Pollution Sources in the Upper Cheliff Region North-Western Algeria

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Abstract—Past or present human activities, particularly industrial activities, but also agricultural and domestic, release into the environment products and potentially harmful substances, called contaminants or pollutants. These are released into the natural environment (water and soil). Their presence, particularly in groundwater poses a disciplinary problem at the interface of ecosystems and water resources. For the assessment of pollution loads arriving at the aquifer of the upper Cheliff, we have established thematic maps on a GIS support for the tablecloth showing the various sources of pollution (livestock, landfills, hospital discharges, domestic waste, industrial activities and service stations...). The classification of production units and service activities, according to their degree of pollution, is done in two steps: The first step is to express the pollution load of each type of activity Equivalent Habitant, which is based on the quantity production. The second step is to locate the sources of pollution on a map to show the impact of this source of pollution on water resources. The alluvial aquifer of Upper Cheliff is exposed to various sources of pollution related mainly to agriculture (the area is for agricultural use), aquifer seems to be heavily contaminated with nutrients from agriculture, following the use of fertilizers more than necessary for plants. Furthermore, urban wastes, spills without any treatment into the environment, are a major source of pollution. No industrial units investigated have a treatment system of their liquid effluent, which is a major risk of water resources pollution. Poultry production is important, hence a significant pollutant load, especially in the upper Cheliff Valley. The pollution load of slaughterhouses is very high because it contains blood and other polluting waste. The pollution load of hospitals is very low due to the processing of their waste. Furthermore, over 57,487 tons of domestic waste is deposited annually in 12 uncontrolled places. The results obtained from this study on the sources of pollution, have shown that nitrates are the variable anthropogenic could actually cause water contamination of the water table so we brought a special interest has the agriculture. The criminalization of agriculture in the contamination of groundwater by nitrates is now highlighted.

Keywords—Sources of pollution, equivalent Habitant , groundwater resources, Upper Cheliff.

Impact of Egypt's Energy Demand on Oil and Gas Power Systems Environment

Moustafa Osman Mohamed

***Abstract*—**This paper will explore the influence of energy sector in Arab Republic of Egypt which has shared its responsibilities of many environmental challenges as the second largest economy in the Middle East (after Iran). Air and water pollution, desertification, inadequate disposal of solid waste and damage to coral reefs are serious problems that influence environmental management in Egypt. The intensive reliance of high population density and strong industrial growth are wearing Egypt's resources, and the rapidly-growing population has forced Egypt to breakdown agricultural land to residential and relevant use of commercial ingestion. The depletion effects of natural resources impose the government to apply innovation techniques in emission control and focus on sustainability. The cogeneration will be presented to control thermal losses and increase efficiency of energy power system.

***Keywords*—**Cogeneration, energy indicators, power plant, electricity, environmental loads, environmental impact assessment.

I. Introduction

ENERGY in Egypt is nearly economic indicator to measure or evaluate consumption rate as tripled over the past two decades, from 0.7 quadrillion Btu (British thermal unit) (Quads) in 1980 to 2.04 Quads in 2000. Industrial demands tapped more than half of the nation energy (53.6%) in 1997 while one quarter each went to the transportation (24.7%) and residential use (22.1%) [1]. A historical summery of Egypt's total primary energy production (TPEP) and consumption (TPEC) is shown in Table I [2].

TABLE I
EGYPT'S TPEP AND TPEC, 1990-2000 (IN QUADS) [2]

	1990	**1991**	**1992**	**1993**	**1994**	1995
TPEP	2.36	2.4	2.44	2.55	2.59	2.67
TPEC	1.44	1.43	1.43	1.51	1.55	1.58
	1995	**1996**	**1997**	**1998**	**1999**	2000
TPEP	2.67	2.73	2.61	2.58	2.69	2.66
TPEC	1.58	1.73	1.80	1.87	1.91	2.04

II. Main Energy Sources in Egypt

Egypt exports fuel oil and naphtha, but imports kerosene and diesel. So, thermal power plant mainly depends on gas turbine rather than diesel generators. The production and consumption are mentioned in Table II [3].

***Crude Oil Prices*:** The average price of domestic crude oil at the wellhead was $23.37 per barrel in November 2002, 43% above the level of November 2001. The refiner acquisition cost of imported crude oil in November 2002 was $23.68 per barrel [3]

Natural gas is destined to become more and more important to energy future in Egypt. There are vast reserves of natural gas with a potential for more discoveries, especially in the western desert, the Nile delta and under the Mediterranean Sea. Proven reserves stand at 42.5 trillion cubic feet (tcf) with probable reserves estimated at 120 tcf, based on seismic offshore data [3].

TABLE II
PETROLEUM PRODUCTION AND CONSUMPTION IN EGYPT 1990-2000 (IN THOUSAND B/D) [3]

	1990	**1991**	**1992**	**1993**	**1994**	**1995**
Production (total)*	914	920	927	946	955	981
Production (crude Oil only)	873	874	881	890	896	920
Consumption	465	456	444	450	448	458
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Production (total)*	981	988	928	910	928	851
Production (crude Oil only)	920	922	856	834	852	748
Consumption	458	501	531	555	550	540

* includes crude oil, natural gas plant liquids, and refinery processing gas

TABLE III
DRY NATURAL GAS PRODUCTION AND CONSUMPTION IN EGYPT, 1990-2000 (IN TCF) [3]

	1990	**1991**	**1992**	**1993**	**1994**	**1995**
Production	0.29	0.32	0.35	0.4	0.42	0.44
Consumption	0.286	0.321	0.349	0.399	0.423	0.439
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Production	0.44	0.47	0.48	0.49	0.52	0.65
Consumption	0.439	0.473	0.477	0.485	0.518	0.646

Note: "dry" gas means gas with condensates removed.

Egypt has been increasing domestic gas demand by converting its power plants to run on gas. Thermal power plants account for about 65% of Egypt's total gas consumption. Large industrial consumers have also been switching to gas including large industrial projects (e.g. petrochemical, fertilizers and steel) in Suez, Alexandria and south of Aswan. Some 20,000 vehicles in Cairo have been modified to run on CNG as of a pilot program. This encourages the government in construction 17 CNG service stations for supporting the project. Egypt is trying to improve the availability of natural gas for residential customers by

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allocating service areas to several private companies, beginning in 1998. British Gas head a group that includes Orascom (an Egyptian construction firm), and Edison International SpA will invest $220 million in a distribution network facility to serve Upper Egypt up to Assyout, that area with no existing gas service. The network may be expanded as far south as Aswan [5]. Natural gas consumption in Egypt by sector is shown in Table IV [6], [7]

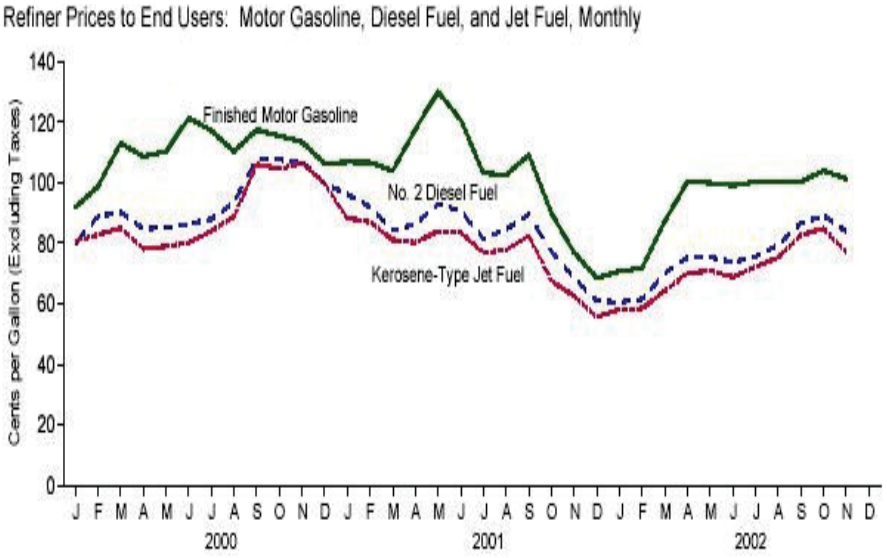

Fig. 1 Refiner prices in cent per gallon [3]

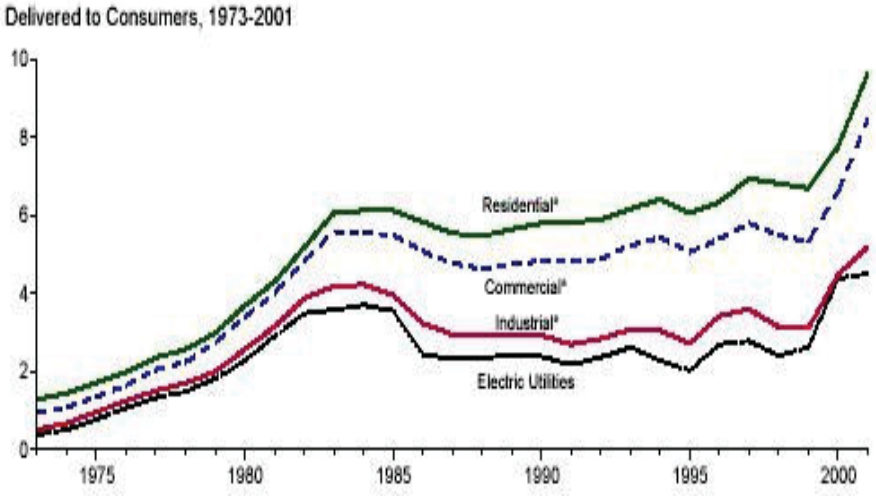

Fig. 2 Natural gas prices (dollars per thousand cubic feet) [4]

TABLE IV
NATURAL GAS CONSUMPTION IN EGYPT BY SECTOR [8]

Sector	Percent of Total
Industrial	59.7
Non-Energy Petrochemical	34.5
Residential	1.6
Transportation	1.4
Other	2.8
Total	**100**

Natural Gas Prices: The average wellhead prices of natural gas for October 2002 were estimated as $3.35 per thousand cubic feet, 40% higher than the October 2001 price [9]. The average price of natural gas delivered to electric utility plants was $3.75 per thousand cubic feet in September 2002 (latest date for which data are available), 19% higher than September 2001 price [9]. The average price of natural gas used by residential consumers in October 2002 was $4.46 per thousand cubic feet, 3% higher than the October 2001 price. The average price of natural gas used by commercial consumers in October 2002 was $6.74 per thousand cubic feet, 5% higher than the October 2001 price. The average price of natural gas used by industrial consumers in October 2002 was $4.11 per thousand cubic feet, 26% above the October 2001 price [9].

Nuclear power in Egypt does not generate commercial amount of electricity from nuclear power source but it does have one 2 MWe nuclear reactor the ET-RR-1 research

reactor, for scientific research and making radioactive isotopes [10], [11].

Coal in Egypt has begun mining in 1995 at El Maghara in the Sinai Peninsula but in the present time Egypt imports a large number of coal to cover the shortage in production natural gas [12].

Hydroelectric power is an important source of energy in Egypt and represent one quarter of total energy production and it is mainly in Aswan [13].

Other renewable energies in Egypt rarely dominate commercial sector but government is looking to expand its renewable energy capacity. Renewable energy generation from solar and wind power are increased by 10% in 1997 to 176 trillion Btu. One example of Egypt's increased commitment to the development of solar power is the Noor Al Salam ("light of peace"), plant to be built near the red sea, which will generate electricity via solar power during the day and natural gas at night. The United States, Israel and Egypt have worked together to develop the design of the plant and the world environmental agency will contribute $65 million [14].

TABLE V
COAL PRODUCTION AND CONSUMPTION IN EGYPT, 1990-2000 (IN MILLIONS OF SHORT TONS) [14]

	1990	1991	1992	1993	1994	1995
Production	0.00	0.00	0.00	0.00	0.00	0.00
Anthracite	n/a	n/a	n/a	n/a	n/a	n/a
Bituminous	n/a	n/a	n/a	n/a	n/a	n/a
lignite	n/a	n/a	n/a	n/a	n/a	n/a
consumption	**1.60**	**1.29**	**1.25**	**1.63**	**1.72**	**1.18**
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Production	0.00	0.11	0.39	0.41	0.43	0.44
Anthracite	n/a	n/a	n/a	N/a	n/a	n/a
Bituminous	n/a	0.11	0.39	0.41	0.43	0.44
lignite	n/a	n/a	n/a	N/a	n/a	n/a
consumption	**1.18**	**1.75**	**1.92**	**2.12**	**2.15**	**2.16**

Note: "n/a" not applicable

III. ENERGY GENERATION AND CONSUMPTION

Egypt's demand for electricity increased dramatically during the decade of the 1990s. to meet that demand, generation from both hydroelectric (16% - mostly from Aswan High Dam) and thermal electric power sources (84% - generated by gas turbine) also increased. An historical summery of electricity generation and consumption is shown in Table VI [15].

Thermal power plants can burn various fuels. These power facilities use natural gas, heavy oil and coal as fuel sources in nearly close prices as shown in Fig. 3 [15].

TABLE VI
ELECTRICITY GENERATION AND CONSUMPTION IN EGYPT, 1990-2000 (IN BILLION (kw/hr)) [15]

	1990	1991	1992	1993	1994	1995
Net Generation	41.4	42.6	43.5	47.8	50.1	52.1
Hydroelectric	9.9	8.5	8.5	10.4	10.6	10.7
Nuclear	n/a	n/a	n/a	n/a	n/a	n/a
Geo/solar/wind/biomass	n/a	n/a	n/a	n/a	n/a	n/a
Conventional thermal	31.5	34.0	35.0	37.4	39.4	41.4
Net Consumption	**38.5**	**39.6**	**40.5**	**44.4**	**46.6**	**48.4**
Import	0.00	0.00	0.00	0.00	0.00	0.00
Export	0.00	0.00	0.00	0.00	0.00	0.00
	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Net Generation	52.1	51.8	54.8	59.2	64.7	69.6
Hydroelectric	10.7	11.4	11.9	12.1	15.1	15.9
Nuclear	n/a	n/a	n/a	n/a	n/a	n/a
Geo/solar/wind/biomass	n/a	n/a	n/a	n/a	n/a	n/a
Conventional thermal	41.4	40.3	43.0	47.1	49.5	53.7
Net Consumption	**48.4**	**48.1**	**51.0**	**55.1**	**60.2**	**64.7**
Import	0.00	0.00	0.00	0.00	0.00	0.00
Export	0.00	0.00	0.00	0.00	0.00	0.00

Note: "n/a" not applicable

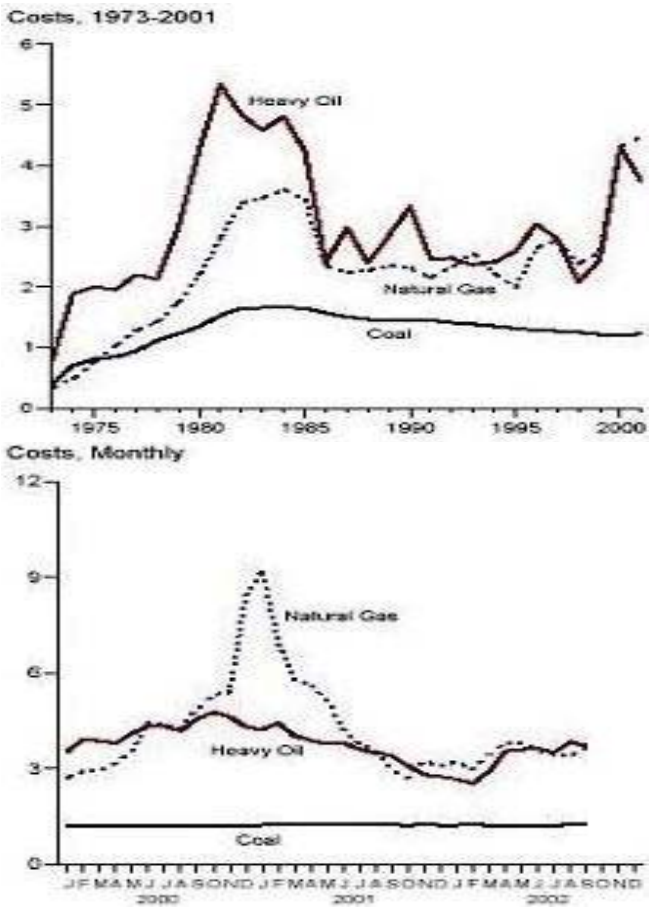

Fig. 3 Cost of Fossil-Fuel Receipts at Steam-electric Utility Plant (Dollars per Million Btu) [15]

IV. AIR POLLUTION

Air pollution is a serious problem in Egypt cities and industrial areas. Concentrations of sulphur dioxide are four

times, smoke and lead levels are three times, and nitrogen oxides are two times worse than world health organization (WHO) guidelines [16]. The sandy storms increase the level of particulate matters and concentrate total suspended particulate matter from 5-10 times than the minimum acceptable standards from WHO. In some areas of the city, lead levels can climb to more than 20 times the maximum WHO exposure levels. Between 10,000 and 25,000 deaths a year in Cairo can be attributed to air pollution [16]

A. Greenhouse Gas Emissions

Egypt's carbon emissions increased 170% from 11.7 million metric tons in 1980 to 31.6 million tons in 1998, mostly due to increased energy consumption. Emission levels have risen 21% since 1990. As the baseline for Kyoto Protocol of the United Nations Framework Convention on Climate Change, as a non-Annex I country under the Convention, Egypt is not required to cut its carbon emissions. Although Egypt has not yet ratified the Protocol, it is a signatory, and Egypt stands to benefit from the Protocol's implementation.

Egypt's carbon emissions per capita are significantly lower than most developed countries. At a rate of 0.5 metric tons of carbon emitted per person in 1998, Egypt's emissions were substantially below the U.S. value of 5.5 metric tons of carbon per capita. Petroleum accounts for 72% of carbon emissions in Egypt, natural gas 25%, and the coal is responsible for 3%. The increasing reliance on natural gas should work to lower carbon emissions. An historical summary of carbon dioxide emission in Egypt is shown in Table VII [17].

TABLE VII
FOSSIL FUEL-RELATED CARBON DIOXIDE EMISSION IN EGYPT, 1990-2000 (IN MILLIONS OF METRIC TONS OF CARBON [17]

(a)	1990	1991	1992	1993	1994	1995
CO_2 from coal	1.02	0.81	0.72	0.87	0.83	0.54
CO_2 from natural gas	4.90	6.01	6.39	6.66	6.98	7.19
CO_2 from petroleum	19.61	19.18	18.59	18.75	19.3	19.09
Total CO_2 from all fossil fuel	**25.54**	**25.99**	**25.69**	**26.28**	**27.10**	**26.82**
(b)	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
CO_2 from coal	0.54	0.95	1.02	1.11	1.12	1.13
CO_2 from natural gas	7.19	7.68	7.71	7.77	8.27	10.17
CO_2 from petroleum	19.09	20.75	21.89	22.86	22.28	21.88
Total CO_2 from all fossil fuel	**26.82**	**29.38**	**30.62**	**31.74**	**31.67**	**33.18**

B. Power Plant Air Pollutant Emissions Factors

Emission factors are used for a variety of purposes at the energy commission; electric system simulation modeling (modeling; mass-of-emission per unit-energy output-input or time), power plant licensing (siting; units of mass-of-emission per unit time) and other related applications. Mainly, emission levels for most emission types depend upon the type of fuel that is being consumed. Burning coal will release more CO_2 and SO_2 into the atmosphere than will burning natural gas for example, NO_x and VOC_s are much depended on combustion sources and technology type or equipment used than other emission types. Modeling work involves forecasting and back casting to evaluate the effects on emissions (primarily NO_x and SO_x) of various strategies or trends in electricity demand and its supply by generation industry [18].

TABLE VIII
THE EMISSION FACTOR FOR NATURAL GAS [18]

Emission Type	Emission Factor		
	lbs. per million Btu	**lbs. per 1000 cf^3**	**lbs. per Therm**
CO_2	117.080	119.423	11.708
NOx	0.150	0.153	0.015
N_2O	0.00216	0.00220	0.00022
SO2	0.00060	0.00061	0.00006
PM10	0.00186	0.00190	0.000186
VOC	0.00539	0.00550	0.000539
CO	0.0240	0.0245	0.0024
Hg	0/negligible	0/negligible	0/negligible

V. ENERGY AND CARBON INTENSITY

Egypt's energy-intensive oil extraction has resulted in a high level of energy intensity compared to Western Europe, yet squarely in the middle of the oil-producing Middle East region. Egypt's 1998 energy intensity was 31,000 Btu/$1990, which is significantly higher than countries such as Germany (7,300 Btu/$1990) and France (7,400 Btu/$1990), but right on par for the region: Egypt's energy intensity level is slightly higher than Iran's (26,900 Btu/$990) and Libya's (22,600 Btu/$1990), but below Saudi Arabia's (35,100 Btu/$1990). In comparison, U.S. energy intensity in 1998 was 13,400 Btu/$1990 [19].

Egypt's energy intensity should fall as the country implements more energy efficiency and conservation programs. Since 1998, the U.S. Agency for International Development's "Energy Conservation and Environment Program," (ECEP) has provided technical assistance and $19 million plus worth of equipment to over 150 industrial and commercial facilities toward improving energy efficiency in Egypt. The project has overseen the completion of over 30 demonstrations of different energy efficient technologies in industries, resulting in annual energy cost reductions for participating companies of around $14 million. ECEP, which now is in its final phase focusing on sustainability, also estimates that it avoided emissions of thousands of tons of greenhouse gases, including 6,000 tons of carbon monoxide (a 48% reduction), 3,000 tons of nitrogen (a 22% reduction), 17,000 tons of sulfur dioxide (a 28% reduction), and 700,000 tons of carbon dioxide (a 7% reduction) [20].

The reduction in carbon emissions growth, combined with a shift of Egypt's energy mix to more natural gas, should help reduce the country's carbon intensity in coming years. In 1998, Egypt's carbon intensity level was 0.53 metric tons of carbon/thousand U$1990. Although this level compares favorably with other countries in the region--Saudi Arabia's carbon intensity was also 0.53, while Iran's was 0.47, and Libya's was 0.44--it is still several times higher than European averages: France's 1998 energy intensity was 0.08, while Germany's was 0.12. As Egypt begins to use more natural gas

and hydropower, its carbon intensity should fall, perhaps coming closer to the level of the United States (0.21 metric tons of carbon/thousand $1990) or Turkey (0.23) [20].

VI. Conclusion

Egypt's energy power system is concern to estimate factors relevant to quantification impact of fuel combustion. The applied US EPA method of emission factors predict emission loads on environment for assessment energy efficiency to extend control programs in Egypt's power plants.

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Impact of Marketing Orientation on Environment and Firm's Performance

Sabita Mahapatra

***Abstract*—**"Going green" has been an emerging issue worldwide driving companies to continuously enhance their green capabilities and implement innovative green practices to protect the environment and improve business performance. Green has become a contemporary business environmental issue. The resource advantage theory is adopted in the present study to observe the impact of marketing orientation and green innovation practices on environmental and firm's performance. The small and medium firms compared to large firms have different approach towards market orientation as a strategic tool. The present study proposes a conceptual framework regarding the impact of market orientation on environmental and firm's performance through green innovation practices in the context of small and medium scale industries (SMEs). The propositions developed in the present paper would provide scope for future research study to validate the conceptual framework in the emerging economy like India.

***Keywords*—**market orientation, green innovation practices, environment performance, corporate performance and emerging market.

I. Introduction

The excessive use of natural resources in the developing economy causing detrimental impact on the environment has raised concerns [1], [2]. Many countries have established regulations to conserve environment which has resulted in increase in awareness [3], [4] and change in management practices [5]. The environmental regulations are compelling companies to adopt environmentally friendly practices. This would give them competitive advantage [4], [6] and help them to improve and sustain their images and performance [7], [8]. Companies have been striving for acquiring green capabilities and conducting green practices to deal with environmental issues [9], [10]. Companies need to identify the important drivers to facilitate the adoption of green innovations practices [11].

Research suggests that a corporates with market-oriented culture creates a foundation for building competitive advantage [12] and improving firm's performance [13], [14], [15]. Market orientated firms tend to invest in market-based assets to create customer value [16]. Firms with a market orientation align themselves towards the needs and wants of stakeholders who are concerned with the organization's wider responsibilities to society [17]. Market-oriented firms work towards serving their customers based on the market information [18] by identifying and responding to changes in customer demand [19]. With increasing trend for environmentally friendly products and services, firms with market orientation adopt green practices that lead to environmentally friendly production [20]. This study uses resource-advantage theory to propose a conceptual model regarding the relationship between market orientation, green innovation practices, and environmental and firms performance. Further, the model builds the argument that a strong market orientation culture supports environmental sustainability efforts. Although previous studies have provided some evidence of the influence of various factors on green practices, however, there is no empirical research that investigates the association between market orientation and environmental performance and firm's performance. Research interest in market orientation within small and medium scale enterprises (SMEs) sector has been scanty [21]. The present paper develops a conceptual framework regarding the relationships between market orientation, green innovation practice, environmental and firm's performance in the context of SMEs. The study proposes several propositions for future research study.

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II. THEORETICAL FRAMEWORK

Accordingly to resource-advantage theory market orientation is a resource that equips firm with the capability to sense changes in customer demand and satisfying those demands effectively [18]. The immediate impact of market orientation is innovation [22]. Stakeholder's pressure has been a driving force behind adoption of corporate green practices [23]. Manufacturing organizations are responding to demands for environmentally sustainable processes and products by incorporate environmental practices [24].

Proposition 1: Market orientation impacts the adoption of green innovation practices.

There is a growing demand for environmental friendly products and services produced by eco-friendly processes [11], [25]. The resource-advantage theory advocates that firms having market orientation will develop resources to embrace environmental sustainability effort in respond to the demand of customers thereby benefit from improved market offering [26]. Research study has concluded that customer demand for eco-friendly products and processes has become the most important factor influencing environment performance [27]. Reflecting this change in demand, firms with a market orientation will begin to provide such environmentally sustainable products and services [20]. A market orientated culture encourages eco-friendly process and policies and regular assessment of market demand for improved environmental performance.

Proposition 2: Market orientation impacts firm's environmental performance.

Research study has established a strong theoretical and empirical relationship between market orientation and

organizational performance [18]. The market orientation positively effects financial performance of the organisation [28], [29], [20]. Moreover, literature on the impact of market orientation on firm performance has revealed mixed results both in the developed and developing countries [30], [31].

Proposition 3: Market orientation impacts firm's performance.

The green practices can reduce the ecological impact by reducing air emissions and carbon footprints in production processes, without compromising quality, cost reliability or energy efficiency [32]. An empirical study on 230 responded of Hong Kong firms, indicated statistically significant association between organization environmental management capabilities and environmental performance [33]. Environmental management capabilities is defined as the firm's capacity to develop innovative practices like green practices to address the growing environmental expectations of customers, while improving both environmental and financial performances [33].

Proposition 4: Green innovation practices effects environmental performance.

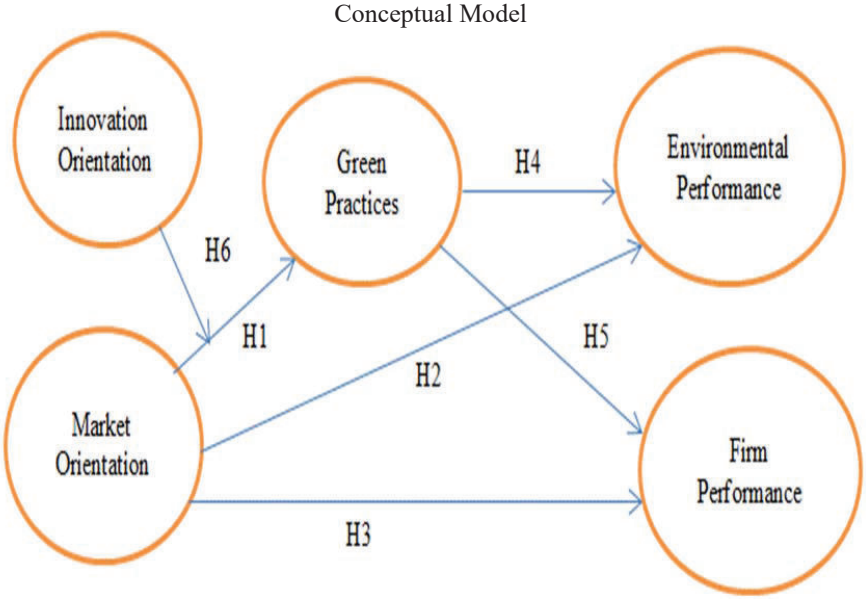
A firm's performance can be measured both financially and non-financially [34]. Financial performance can be measured through resource productivity through green innovation [5], [35] and market expansion through environmental practices [36], [37]. Non-financial performances are manifested by retention and acquisition of new customers, image and reputation of a firm [38], [35], [39]. Chen proposed that companies will have the competitive advantages of first-mover strategy due to green initiatives [7].

Proposition 5: Green innovation practices effects firm's performance.

This study attempts to test the moderating effects of innovativeness on the relationship between market orientation and green innovation practices. Innovation orientation is correlated with business strategy settings and organizational culture, both of which are related mainly to the company philosophy. Innovation orientation is a type of strategic orientation that affects organizational innovation practices and serves as a guiding principle for strategy making and implementation to enhance a company's innovativeness [40], [41]. It describes an organization's openness to new ideas, technologies, skills, resources, and administrative systems [42] and a knowledge system that incorporates a learning philosophy, strategic direction, and trans-functional acclimation within an organization to promote innovation [43]. Organisations known to be innovative exhibit the ability to successfully implement new systems, products, and processes [44]. Innovative oriented companies have leaders who encourage and support employees for innovative conduct. Matear found that innovation influences the relationship between market orientation and performance [45].

Proposition 6: Innovation orientation moderates the relationship between market orientation and green innovation practices.

Conceptual Model



III.CONCLUSION

Green innovation should be encouraged not only as reaction to fulfil government requests but as a proactive practice for competitive advantage and business performance [35]. Firms are expected to commit to green practices with increasing public pressure and with the cost of raw materials and energy continuing to rise. While the costs of such efforts can be substantial, improved environmental performance would lead to long-term sustainability. Firms worldwide are cognizant about the advantage of environmentally friendly products and strategies, thereby increasingly focusing on developing internal and external strategies that encourages green innovation. Developing environmentally friendly goods and services is critical to the success of firms that are attempting to

create innovative products to meet the needs of the ever increasing environmentally conscious consumer.

The conceptual model will serve as encouragement for scholars to undertake research to test the propositions. The findings of an empirical study will establish the relation between firm's market orientation and green innovative practices on environmental and firm's performance. The findings of such study will encourage manager to foster a culture of innovation for green innovation and practices and provide direction to companies for setting company strategies, modifying company structures, providing training courses, offering guideline to follow innovative green products and processes.

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Impacts of Climate Change on Water Resources of Greater Zab and Lesser Zab Basins, Iraq, Using Soil and Water Assessment Tool Model

Nahlah Abbas, Saleh A. Wasimi, Nadhir Al-Ansari

Abstract**—**The Greater Zab and Lesser Zab are the major tributaries of Tigris River contributing the largest flow volumes into the river. The impacts of climate change on water resources in these basins have not been well addressed. To gain a better understanding of the effects of climate change on water resources of the study area in near future (2049-2069) as well as in distant future (2080-2099), Soil and Water Assessment Tool (SWAT) was applied. The model was first calibrated for the period from 1979 to 2004 to test its suitability in describing the hydrological processes in the basins. The SWAT model showed a good performance in simulating streamflow. The calibrated model was then used to evaluate the impacts of climate change on water resources. Six general circulation models (GCMs) from phase five of the Coupled Model Intercomparison Project (CMIP5) under three Representative Concentration Pathways (RCPs) RCP 2.6, RCP 4.5, and RCP 8.5 for periods of 2049-2069 and 2080-2099 were used to project the climate change impacts on these basins. The results demonstrated a significant decline in water resources availability in the future.

Keywords**—**Tigris River, climate change, water resources, SWAT.

I. Introduction

THE water resources of a basin are influenced by a large number of explanatory variables such as precipitation and other meteorological factors, vegetation and other landuse, and natural catastrophes such as hurricanes and bushfires. The water balance is often delicate, which can be easily exacerbated by climate change, especially when water resources are restricted [1]. Climate change can have a considerable impact on the hydrological cycles mainly through the modification of evapotranspiration and precipitation [2], [3]. The alterations of evapotranspiration and precipitation can, at the extreme, demonstrate formations of severe droughts or major floods leading to significant impacts on the water balance of a basin [4]. Greater Zab and Lesser Zab are the largest tributaries of Tigris River in terms of their contribution to Tigris flow. Greater Zab and Lesser Zab contribute about 40%-60% of total Tigris flow [5]. Furthermore, they are the main sources of surface water for Kurdistan region. Water scarcity has been pronounced in recent history in these basins [6]. Up till now, water problems in relation to climate change in the Greater Zab and Lesser Zab catchments have not been well addressed [7]. Therefore, the main objective of this study has been to evaluate the potential impacts of future climatic changes in the water sources of these important basins, specifically blue and green waters. SWAT model was applied to determine the effects of climatic change on the watersheds. The model was set at monthly scale using available spatial and temporal data and calibrated against measured streamflow. Climate change scenarios were obtained from GCMs.

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II. Study Area

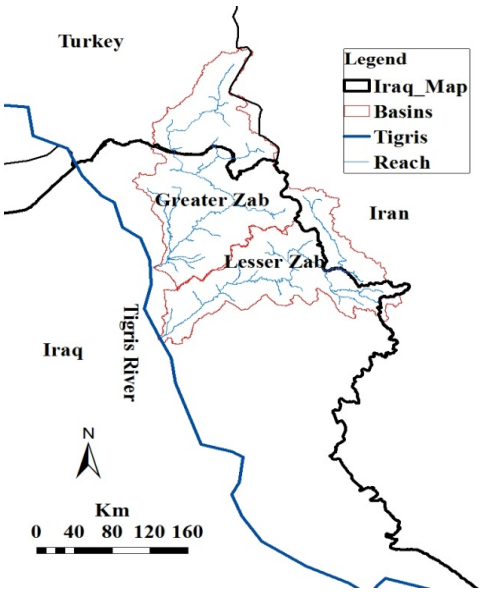


Fig. 1 Location of Greater Zab and Lesser Zab within Iraq

The Greater Zab rises from the Ararat Mountains in Turkey and flows through Turkey and the central northern part of Iraq and then joins the Tigris River south of Mosul City with a length of 372 km. The greater Zab is situated between latitudes 36 ^{0}N and 38^{0}N, and longitudes 43.3 ^{0}E and 44.3 ^{0}E [6] (Fig. 1). It drains an area of 26,473 km^2, 65% of which is located in Iraq and the rest in Turkey [5]. Lesser Zab (also known as Little or Lower Zab) rises from north-eastern Zagros Mountains in Iran running through Iran and Iraq, and after a length of about 302 km, the river links with the Tigris River at Fatah (south of Mosul). The watershed is located approximately between 35.16^{0}N to 36.79 ^{0}N latitudes and its longitudes are 43.39 ^{0}E to 46.26 ^{0}E (Fig. 1). Lesser Zab serves an area of about 15,600 km^2, 80% of which is located in Iraq and the remainder in Iran. The weather of the Greater Zab and

Lesser Zab watersheds is arid to semi-arid with dry and hot summers and wet winters [5]. The average annual temperature is variable from 22 °C in the south to 10 °C in the north. The average annual rainfall varies from 350 mm in the south and 1500 mm in the north [6]. The flow regime of Greater Zab and Lesser Zab demonstrates high seasonal variability with peak flow occurring between April and May primarily due to snowmelt, and low seasonal flow occurring between July and December (Fig. 2). It is estimated that 70% of the catchment is covered by pasture and the rest is utilised for agriculture, Xerosols soil is the dominant in these basins [6].

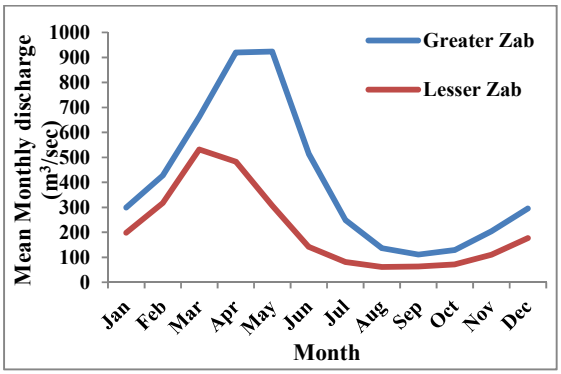


Fig. 2 Average monthly streamflows of Greater Zab and Lesser Zab at EskiKelek and Dukan, respectively during 1979-2004

III. Description of SWAT Model

The SWAT model [8] is a river watershed, physics-based distributed model for analysing hydrology and water quality at different watershed scales with varying soils, land use and management conditions on a long-term basis. The model has two main divisions, land phase and routing phase, which apply to simulate the hydrology of a watershed. The land phase estimates the hydrological mechanisms which comprise evapotranspiration, surface runoff, subsurface water, ponds, lateral flow, channels and return flow [8]. The routing phase controls the movement of water, sediments, nutrients, and organic chemicals via the waterways network of the basin to the outlet [8].

In land phase of the hydrological cycle, the simulation is based on the water balance equation.

$$SW_t = SW_0 + \sum_{i=1}^{n}\left(R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw}\right) \quad (1)$$

where *SWt* (mm) is the final soil water content, *SWo* (mm) is the initial soil water content on day *i*, *t*(days) is the time, R_{day} (mm) is the amount of precipitation on day *i*, Q_{surf} (mm) is the amount of surface runoff on day *i*, E_a (mm) is the amount of evapotranspiration on day *i*, *Wseep* (mm) is the amount of water entering the vadose zone from the soil profile on day *i*, and Q_{gw} (mm) is the amount of return flow on day *i*. A description of some of the major features of the model is shown in this study, and the full descriptions of the model can be provided in [9].

The estimation of surface runoff is conducted with two methods; the SCS curve number procedure [8] and the Green and Ampt infiltration method [10]. The SCS method was applied in this study due to unavailability of sub-daily data that are essential for the Green and Ampt infiltration method.

The SCS curve number equation is:

$$Q_{surf} = \frac{(R_{day} - 0.2S)^2}{(R_{day} + 0.8S)} \quad (2)$$

where, Q_{surf} (mm) is the accumulated runoff or rainfall excess, R_{day} (mm) is the rainfall depth for the day, *S*(mm) is the retention parameter.

The retention parameter diverges spatially owing to different soils, landuse, management and slope of a catchment and temporally because of soil water content variations. The retention parameter is defined by:

$$S = 25.4\left(\frac{1000}{CN} - 10\right) \quad (3)$$

where *CN* is the curve number for the day.

To estimate the retention component, SWAT 2012 utilizes the modified soil moisture method that permits the retention parameter to differ with plant evapotranspiration.

When the retention component is variable with soil profile water content, the equation below is applied,

$$S = S_{max} * \left(1 - \frac{SW}{[SW + \exp(w_1 - w_2 * SW)]}\right) \quad (4)$$

where *S* (mm) is the retention parameter for a given day, S_{max} (mm) is the maximum value that the retention parameter can achieve on any given day, *SW*(mm) is the soil water content of the entire profile excluding the amount of water held in the profile at wilting point, and w_1 and w_2 are shape coefficients. The maximum retention parameter value, *Smax* (mm), is calculated by solving (3), using CN_1, as shown below,

$$S_{max} = 25.4\left(\frac{1000}{CN_1} - 10\right) \quad (5)$$

In the case where the retention parameter is to be varied with plant evapotranspiration, the following equation is applied to calculate the retention parameter at the end of every day:

$$S = S_{prev} + E_o \exp\left(\frac{-\text{cncoef} - S_{prev}}{S_{max}}\right) - R_{day} - Q_{surf} \quad (6)$$

where S_{prev} (mm) is the retention parameter for the previous day, E_o (mm/day) is the potential evapotranspiration for the day, cncoef is the weighting factor used to estimate the retention coefficient for the daily curve number calculation which depends on plant evapotranspiration, S_{max} is the maximum value of the retention parameter that can be achieved on any given day, R_{day} (mm) is the rainfall depth for the day, and Q_{surf} (mm) is the surface runoff. The initial value of the retention parameter is defined as $S = 0.9S_{max}$.

The model estimates the volume of lateral flow which depends on the variation in conductivity, slope and soil water

content. A kinematic storage model is used to predict lateral flow through each soil layer. Lateral flow is the flow below the soil surface when the water input into a layer exceeds the field capacity after percolation.

Regarding groundwater simulation, the process assumes two aquifers which are a shallow aquifer (unconfined) and a deep aquifer (confined) in each watershed. The shallow aquifer contributes streamflow into the main channel of the watershed.

The water balance equation for the shallow aquifer is:

$$aq_{sh,i} = aq_{sh,i-1} + w_{rchg.sh} - Q_{gw} - w_{revap-} - w_{pump.sh} \quad (7)$$

where $aq_{sh,i}$ (mm) is the amount of water stored in the shallow aquifer on day i, $aq_{sh,i\text{-}1}$(mm) is the amount of water stored in the shallow aquifer on day i-1, $w_{rchrg.sh}$(mm) is the amount of recharge entering the aquifer on day i, Q_{gw} (mm) is the groundwater flow, or base flow, into the main channel on day i, w_{revap} (mm) is the amount of water moving into the soil zone in response to water deficiencies on day i, and $w_{pump,sh}$ (mm) is the amount of water removed from the shallow aquifer by pumping on day i.

The steady-state response of groundwater flow to recharge is calculated by the equation given below [8].

$$Q_{gw} = \frac{8000 * K_{sat}}{{L_{gw}}^2} * h_{wtbl} \quad (8)$$

where K_{sat} (mm/day) is the hydraulic conductivity of the aquifer, L_{gw} (m) is the distance from the ridge or sub-basin divide for the groundwater system to the main channel, and h_{wtbl} (m) is the water table height.

Water infiltrating into the confined aquifer is presumed to contribute to the flow outside the watershed. SWAT model uses three methods to assess potential evapotranspiration (PET) – the Penman-Monteith method [11], the Priestley-Taylor method [12] and the Hargreaves method [13]. Water is directed via the streamflow network by using Muskingum river routing method utilizing the daily time step [8].

SWAT model demands an enormous amount of input data to achieve the tasks visualized in this research. Digital elevation model (DEM), landuse map, soil map, weather data and discharge data are basic data requirements for modelling. DEM was extracted from ASTER Global Digital Elevation Model (ASTERGDM) with a 30-meter grid and 1×1 degree tiles [14]. The land cover map was gathered from the European Environment Agency with a 250-meter grid raster for the year 2000 [15]. The soil map was obtained from the global soil map of the Food and Agriculture Organization of the United Nations (1995) [16]. Weather data which included daily precipitation, maximum and minimum temperatures were collected from the Iraq's Bureau of Meteorology. Monthly streamflow data were obtained from the Iraqi Ministry of Water Resources/National Water Centre.

In SWAT model, the watershed is divided into smaller basins based on the DEM. The landuse map, soil map and slope datasets are embedded in the SWAT databases for this study. The small basins are further sub-divided into Hydrologic Response Units (HRUs). HRUs are defined as parcels of land that have unique slope and soil and landuse area within the borders of a small basin. The HRUs represent percentages of sub-basin areas and hence are not spatially defined in the model. There must be at least one HRU in each small basin. HRUs enable the users to identify the differences in hydrologic conditions such as evapotranspiration for varied soils and landuses. Routing of water and pollutants is accomplished from the HRUs to the sub-basin level and then through the river system to the watershed outlet.

The Sequential Uncertainty Fitting Algorithm application (SUFI-2) is rooted in the SWAT-CUP model [17] was applied to assess the performance of the SWAT. The advantages of SUFI-2 are that it combines optimisation and uncertainty analysis, can handle large number of parameters through Latin hypercube sampling, and it is easy to apply. Moreover, SUFI-2 algorithm was found to achieve good prediction uncertainty with a limited number of runs comparing with other techniques connecting to SWAT such as generalized likelihood uncertainty (GLU) estimation, parameter solution (parsol), Markov Chain Monte Carlo (MCMC). This efficacy is of importance when the model is applying to complex and large basins [17].

Firstly, The SUFI-2 categorizes the dimension for each parameter. Thereafter, Latin Hypercube method is applied to produce different permutations among the calibration parameters. Finally, the model runs with each permutation, and the obtained results are compared with the observed data until the optimum objective function is reached. Because of the uncertainty in forcing inputs (e.g. temperature, rainfall), conceptual model and errors in measured data which are unavoidable in hydrological models, SUFI-2 algorithm computes the uncertainty of the measurements, the conceptual model and the parameters by two separate measures: P-factor and R-factor. P-factor is the percentage of data included by the 95% prediction uncertainty (PPU) which is bounded at 2.5% and 97.5% of the cumulative probability distribution of an output variable obtained from Latin Hypercube Sampling – it is similar to 95% confidence interval construction. The R-factor, which is standardized value, is the average width of the 95 PPU divided by the standard deviation of the corresponding measured variable. In an ideal scenario, P-factor tends towards 1 and R-factor towards zero. Furthermore, SUFI-2 calculates the Coefficient of Determination (R^2) and the Nasch-Sutcliff efficiency (ENC) [18] to assess the goodness-of-fit between the measured and simulated data.

The ENC value indicates how well the plot of the observed against the simulated values fits the 1:1 line. It ranges from negative infinity (-∞) to one. The nearer the value to 1, the better is the prediction, while the value of less than 0.5 indicates unsatisfactory model performance [19]. ENC is calculated as shown below:

$$ENC = 1 - \left[\frac{\sum_{i=1}^{n}(O_i - P_i)^2}{\sum_{i=1}^{n}(O_i - \bar{O})^2}\right] \quad (9)$$

where O_i is the observed streamflow, P_i is the simulated streamflow, and $\bar{O}$ is the mean observed streamflow during the evaluation period.

SUFI-2 allows users to accomplish global sensitivity analysis, which is computed based on the Latin Hypercube and multiple regression analysis. The multiple regression equation is defined as:

$$g = \alpha + \sum_{i=1}^{m} \beta_i * b_i$$

where g is the value of the evaluation index for the model simulations, α is a constant in the multiple linear regression equation, β is a coefficient of the regression equation, b is a parameter produced by the Latin hypercube method, and m is the number of parameters.

The t-stat of this equation which can indicate parameter sensitivity is applied to determine the relative significance of each parameter, the more sensitive the parameter, greater is the absolute value of the t-stat. When p-value is used, it is also an indication of the significance of the sensitivity, p-value close to zero has more significance.

Six GCMs from CMIP5 namely CGCM3.1/T47, CNRM-CM3, GFDL-CM2.1, IPSLCM4, MIROC3.2 (medres), and MRI CGCM2.3.2 were selected for climate change projections in the Lesser Zab basin under a very high emission scenario (RCP 8.5), a medium emission scenario (RCP 4.5) and a low emission scenario (RCP 2.6) for two future periods (2049-2069) and (2080-2099). Thereafter, the modelled temperatures and precipitation were input to the SWAT model and then water assets in the basin compare with the baseline period (1980-2010). BCSD method was applied to downscale the GCM results [20].

IV. Results and Discussion

A. Sensitivity Analysis

Sensitivity analysis was carried out for 25 parameters related to streamflow [8], from which 12 most sensitive parameters were considered for implementing in the model for calibration of the Greater Zab Basin. The rankings of 12 highest sensitive parameters for each watershed are presented in Table I. For Greater Zab, SFTMP was the greatest sensitive parameter. However, it was ranked the eighth for Lesser Zab. These results seem rational as Greater Zab river is snow-dominated mountainous terrain. CN2 was the dominant SWAT calibration parameter for Lesser Zab. However, it was ranked the fourth for Greater Zab. In a large number of SWAT applications in other watersheds, CN2 was the highest sensitive parameter [21]. CN2 tends to have the main impact on the quantity of runoff produced from the HRU, thus a relatively high sensitivity index can be expected for most of the basins [22]. SOL_AWC came third for Greater Zab and Lesser Zab. ALPHA-BE was observed to be the highest sensitive parameter among the four groundwater parameters for both watersheds. ALPHA-BE was ranked the second for Greater Zab and Lesser Zab. These results are similar to the findings of Li et al. [23] who found that ALPHA-BE is a highly sensitive groundwater parameter in SWAT calibrations. SWAT was observed to be relatively sensitive to GW-DELY for Lesser Zab.

TABLE I
RANKS OF 12 HIGHEST SENSITIVE PARAMETERS RELATED TO STREAMFLOW IN THE TWO BASINS IN IRAQ

Parameter	Greater Zab	Lesser Zab
CN2	4	1
ALPHA_BF	2	2
SFTMP	1	8
SOL_AWC	3	3
GW_DELAY	12	4
ESCO	8	11
HRU_SLP	5	7
SURLAG	7	5
GW_REVAP	11	6
GWQMN	9	9
SLSUBBSN	6	12
CH_K2	10	10

B. Calibration and Validation

In both the basins, in spite of overestimates and underestimates during wet months, the model performed well over the whole simulation periods (Table II). The underestimation and overestimation during some months could be because of errors in measuring flow, unequally spread rainfall stations and spatial variability in soil and land use [24], [25]. Generally, the model can be assumed from the results to be capable of simulating the streamflow of the two basins.

TABLE II
R^2 AND ENC VALUES IN THE BASINS

		Calibration		Validation	
Watershed	Station	R^2	ENC	R^2	ENC
Greater-Zab	Bekhme	0.69	0.66	0.89	0.53
Greater-Zab	Bakrman	0.53	0.50	0.66	0.52
Greater-Zab	EskiKelek	0.58	0.56	0.57	0.51
Lesser-Zab	Alulnkubri	0.77	0.76	0.87	0.73
Lesser-Zab	Dokan	0.58	0.54	0.76	0.71

C. Impacts of Climate Change on Tigris Basin Using CMIP5

1) Precipitation Forecasts

Overall, all selected GCMs projected a reduction in the mean annual precipitation at about the mid-century (2049-2069) and about one-century lead time (2080-2099) for the two basins. Fig. 3 illustrates the anomaly maps of precipitation distribution (maps of percent deviation from historical data, (1980-2010) for RCP 2.6, RCP 4.5 and RCP 8.5 scenarios for the periods 2049-2069 and 2080-2099 for the average change from the multi-GCM ensemble. Under the RCP 2.6, Greater Zab is expected to experience a decrease of about 12% while the Lesser Zab 2% for the mid-century. At the end of the century, Greater Zab will experience nearly the same reduction, 15%, whereas Lesser Zab will experience a reduction of 10%. RCP 4.5 produced nearly the same reduction (average -18%) for both the basins in the mid-

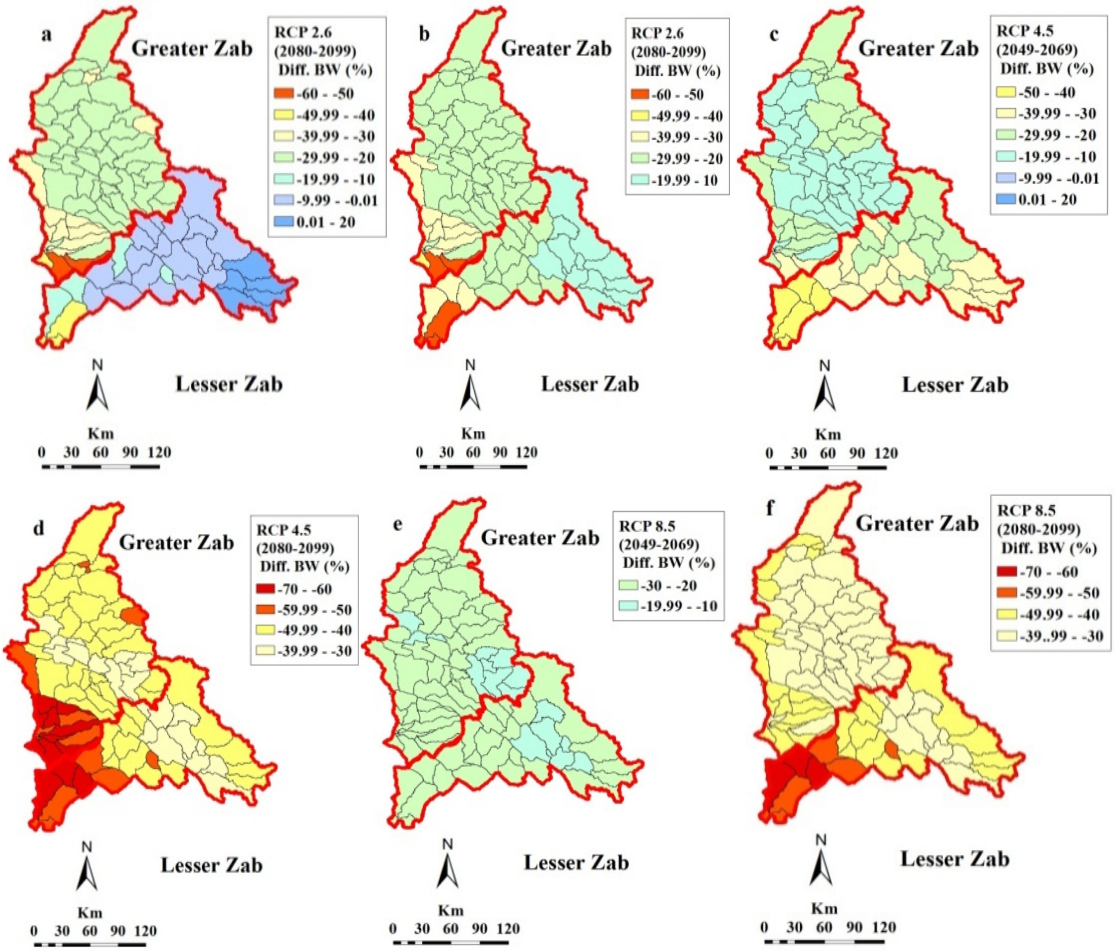
century, whereas at the end of the century, Greater Zab will see reduction of about -15%; however, the Lesser Zab will see 26% reduction. RCP 8.5 produced the same decreases for the half a-century in the two basins (17%), while for the end of the century, Greater Zab will experience a decline of about 22% and Lesser Zab 18%.

D.Blue Water and Green Water Forecasts

Fig. 4 captures the anomaly maps of blue water distribution (maps of percent deviation from historical data, 1980-2010) for RCP 2.6, RCP 4.5, and RCP 8.5 scenarios for the periods 2049-2069 and 2080-2099 from the average change of the multi-GCM ensemble. Under RCP 2.6, the half-a-century projection (2049-2069) shows a decline of about 29% and 22% in Greater Zab and Lesser Zab, respectively, while at the end of the century the reduction will be nearly the same in both the basins (27%). For RCP 4.5 (2049 -2069), Lesser Zab will see a decrease of about 33% followed by Greater Zab (20%). For RCP 4.5 (2080-2099), both the basins will experience approximately similar reduction of about 46%. Under RCP 8.5 both basins will experience a reduction of about 23% for the period of (2049-2069). However, the Lesser Zab and Greater Zab will see a reduction of about 51% and 43%, respectively, for the period of (2080-2099). Green water has a tendency to have a similar trend as the blue water (Fig. 5).

Fig. 3 The impacts of climate change on the precipitation of the two basins (a) Anomaly based on scenario RCP 2.6 for the period 2049-2069, (b) Anomaly based on RCP 2.6 for 2080-2099, (c) Anomaly based on RCP 4.5 for 2049-2069, (d) Anomaly based on RCP 4.5 for 2080–2099, (e) Anomaly based on RCP 8.5 for 2049-264, and (f) Anomaly based on RCP 8.5 for 2080–2099.

Fig. 4 The impacts of climate change on the blue water of the two basins (a) Anomaly based on scenario RCP 2.6 for the period 2049-2069, (b) Anomaly based on RCP 2.6 for 2080-2099, (c) Anomaly based on RCP 4.5 for 2049-2069, (d) Anomaly based on RCP 4.5 for 2080–2099, (e) Anomaly based on RCP 8.5 for 2049-264, and (f) Anomaly based on RCP 8.5 for 2080–2099.



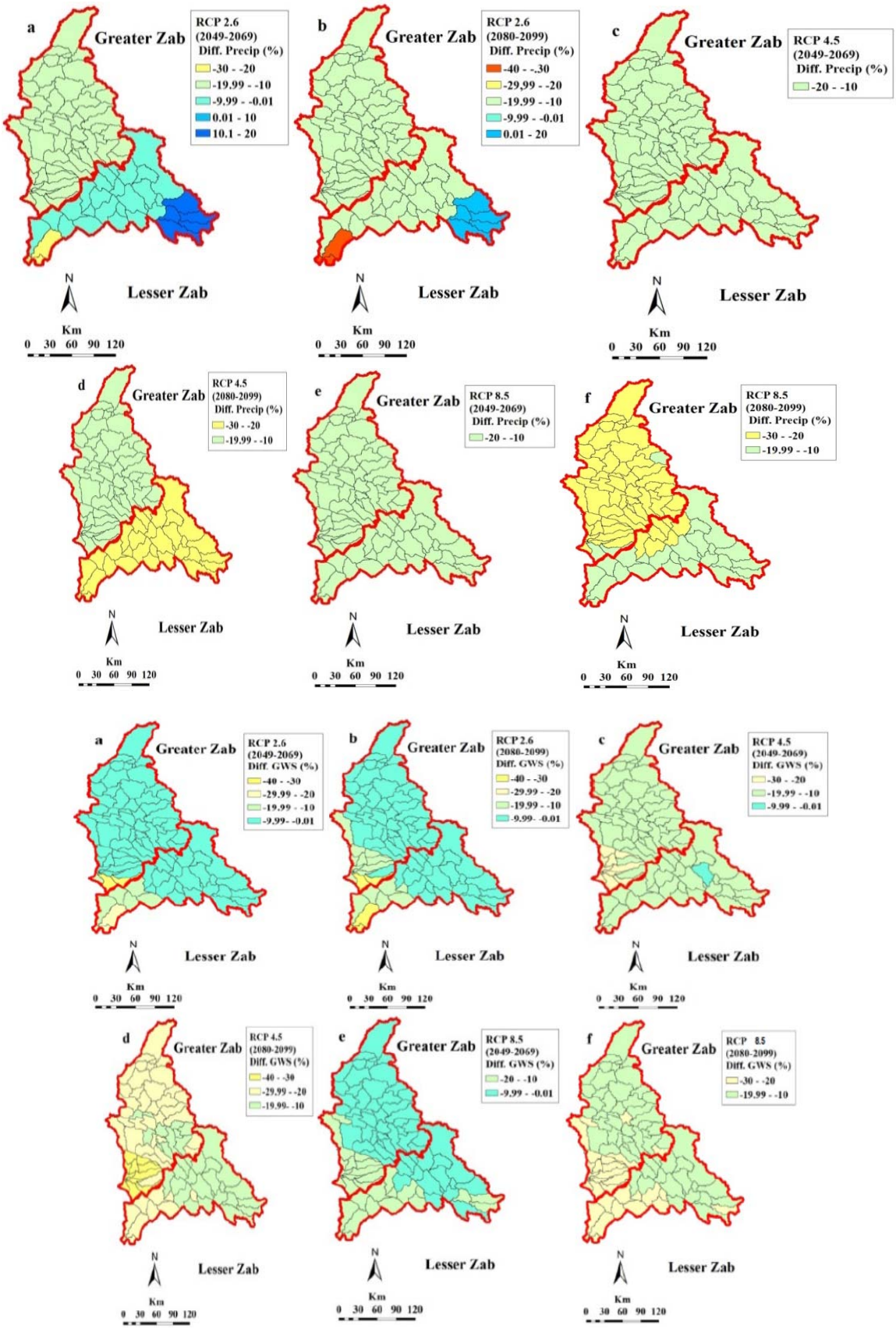


Fig. 5 The impacts of climate change on the green water of the two basins (a) Anomaly based on scenario RCP 2.6 for the period 2049-2069, (b) Anomaly based on RCP 2.6 for 2080-2099, (c) Anomaly based on RCP 4.5 for 2049-2069, (d) Anomaly based on RCP 4.5 for 2080–2099, (e) Anomaly based on RCP 8.5 for 2049-264, and (f) Anomaly based on RCP 8.5 for 2080–2099

V. Conclusion

The findings from the SWAT model obviously reveal that the water system of the Greater Zab and Lesser Zab basins are likely to undergo alterations due to climate change, and most likely for the worse. The forecasts in the availability of water resources show declining trends. Since water is a limited resource for the region, a policy to deal with the adversity of the future is necessary. Certainly, preemptive intervention and pro-active actions would be highly beneficial and cost effective in the long term for the future generations.

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Invasion of *Pectinatella magnifica* in Freshwater Resources of the Czech Republic

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Abstract*—Pectinatella magnifica* (Leidy, 1851) is an invasive freshwater animal that lives in colonies. A colony of *Pectinatella magnifica* (a gelatinous blob) can be up to several feet in diameter large and under favorable conditions it exhibits an extreme growth rate. Recently European countries around rivers of Elbe, Oder, Danube, Rhine and Vltava have confirmed invasion of *Pectinatella magnifica*, including freshwater reservoirs in South Bohemia (Czech Republic). Our project (Czech Science Foundation, GAČR P503/12/0337) is focused onto biology and chemistry of *Pectinatella magnifica*. We monitor the organism occurrence in selected South Bohemia ponds and sandpits during the last years, collecting information about physical properties of surrounding water, and sampling the colonies for various analyses (classification, maps of secondary metabolites, toxicity tests). Because the gelatinous matrix is during the colony lifetime also a host for algae, bacteria and cyanobacteria (co-habitants), in this contribution, we also applied a high performance liquid chromatography (HPLC) method for determination of potentially present cyanobacterial toxins (microcystin-LR, microcystin-RR, nodularin). Results from the last 3-year monitoring show that these toxins are under limit of detection (LOD), so that they do not represent a danger yet. The final goal of our study is to assess toxicity risks related to fresh water resources invaded by *Pectinatella magnifica*, and to understand the process of invasion, which can enable to control it.

***Keywords*—**Cyanobacteria, freshwater resources, *Pectinatella magnifica* invasion, toxicity monitoring

I. Introduction

PECTINATELLA MAGNIFICA (Leidy, 1851) (*PM*) is a bryozoan species spreading with an invasive character. A native area of the animal is the east part of the Mississippi River, from Ontario to Florida, where it was observed already in 19th century. Since then, *PM* has been spreading also to Korea, India, Japan, and Turkey. In Europe, it has been recorded in Germany, Romania, Turkey, and France. Its occurrence in the Netherlands has been first reported in 2003. The newest discoveries are for the Rhine basin in the area between Luxembourg and Germany. Recently, it was also recorded in the Czech Republic [1].

A colony of *Pectinatella magnifica* is built from a gelatinous matrix covered by hundreds of individual filter feeding zooids. Owing to its massive occurrence, it presumably has an important influence on the ecosystem (species composition, trophic level, and hydro-chemistry). Large *PM* colonies can also clog water intake and irrigation pipes creating economic and engineering challenges. Therefore, the implication of *PM* invasion in the freshwater reservoir concerns not only biology but also ecology, planning of further usage of water supply resources and thus the quality of life.

The knowledge about chemistry of *PM*, about its second metabolites, and also the recognition of the state, development and plankton dynamics (which affects the food chain) of sandpits, ponds and rivers with *PM* colonies is a key for understanding and controlling the invasion.

In order to understand the invasion in a complex way, this paper consists of three separated parts concerning i/ statistical evaluation of *PM* spread during the season 2015, ii/ analysis of bacteria related to *PM* and microbiological activity of *PM* extracts, iii/ selected chemical analysis of lyophilized *PM* samples.

II. Statistical Evaluation of *Pectinatella magnifica* Colonies in Area Třeboňsko, 201 Seasons

A. Invasion of Pectinatella magnifica in Area Třeboňsko: Biomass Production

In the Protected Landscape Area and Biosphere reserve "Třeboňsko" the bryozoan was first found in 2003 in a mesotrophic sandpit. Then, the species gradually spread to many other sites on the Třeboňsko area and at most of these locations its occurrence has invasive properties [2].

The most important parameter affecting *PM* occurrence is the low trophicity of water, thus it expanded to some gravel sandpits and fishponds without intensive pisciculture. Colonies of this invasive bryozoan in this area are found typically on submerged branches of willow trees [3].

Biomass, expressed by weight and the number of colonies, is an important factor in terms of the potential production of biologically active substances. Higher biomass production means a higher amount of zooids, thus more metabolically active units of *Pectinatella magnifica*. In addition, a larger amount of biomass means higher volume of the matrix that is colonized by other potential producers of biologically active substances: algae, cyanobacteria and bacteria. Therefore, the monitoring of amount of biomass is one of the basic work for following studies.

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B. Statistical Methods

1) Data Collection Methods

Sample collection was carried out at five localities – two gravel sandpits of "Cep" and "Veselí I", and three ponds of "Podřezaný", "Hejtman", and "Nový Kanclíř". Six transects were chosen on each locality in the length of 10 m along the shore and of width 5 m. All colonies found in these transects were measured and weighted. Sample collection was duplicated on identical transects in July 2015 (first sampling) and August 2015 (second sampling).

2) Data Analysis Methods

The exploratory data analysis was performed by bar charts and the interference analysis by analysis of variance. A Kruskal-Wallis test was chosen, as the data were not normally distributed.

The localities were used as the independent variables, while the dependent ones were the biomass, number of colonies and the average colony mass. The null hypotheses were designed so, that the biomass/number of colonies/average colony mass do not differ between the colonies. The critical significance level was set equally for all analyses comparing the dependent variables to α=0.05. For comparing the dependent variables this significance level was adjusted following Bonferroni to α=0.02. Next, the H-statistics were computed and compared to the critical value $\chi 2$ — distribution with m-1 degrees of freedom. The null hypothesis was rejected, whenever the statistical value was higher than the value of $\chi 2$ — distribution with m-1 degrees of freedom.

C. Results

1) The Exploratory Data Analysis

Biomass

A total amount of biomass was higher for the first sample collection in July 2015 at all of the localities. On Hejtman, Cep and Veselí I, no colonies were found during the second collection and on Nový Kanclíř only one colony was found in August, weighing 1.7 kg. The reason for the lack of colonies in the second term of collection of 2015 were probably unusual climatic conditions (see Conclusions, part D).

The biggest biomass from the collection in July (129.4 kg) was found on pond Nový Kanclíř. Quite high level of biomass (compared to previous years) was found on the pond Podřezaný (409 kg). It was also considerably higher than the biomass found on other localities – Veselí I (41 kg), Hejtman (25 kg) and Cep (0.6 kg).

Colony Number

The highest number of colonies within the first collection was found on the gravel sandpit Veselí I (282), and on Nový Kanclíř (257), significantly lower on Hejtman (48) and the lowest on Cep (12). Within the second collecting in August, no colonies were found on three localities (Hejtman, Cep and Veselí I). On the pond Nový Kanclíř, only a single colony was found. Considerably higher amount within the second sampling was only found on Podřezaný pond (450 colonies in comparison to 258 in the first sampling).

Average Colony Mass

The average colony mass was calculated as a ratio of the cumulative mass collected in the six transects at a given locality divided by the total number of colonies counted there. The highest average colony mass from the first sampling was recorded on the pond Podřezaný (1.58 kg), huge colonies with the average weight of 1.08 kg were found also on Nový Kanclíř. The average colony mass on Hejtman was 0.52 kg, and the lowest on the gravel sandpit Cep (0.05 kg).

Average colony masses for the five localities in the season 2015 are plotted in Fig. 1 (white bars). Due to the lack of colonies in August 2015 on most of the localities, the second collection was not considered for the calculation of an average. For comparison, there adequate data from previous season (2014) were added to the graph (grey bars).

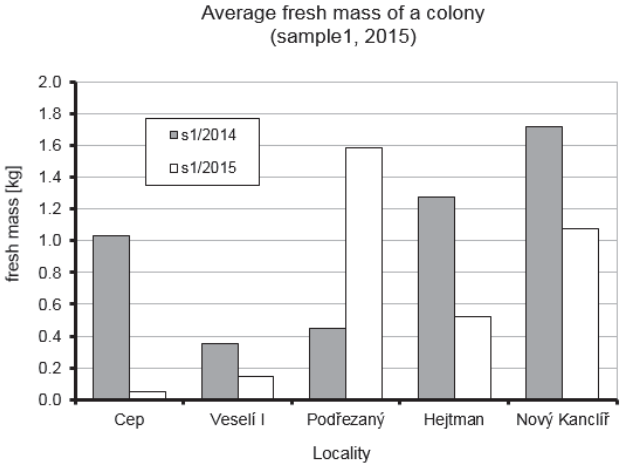

Fig. 1 Comparison of the average fresh mass of a *PM* colony at five localities in season 2015 (white bars) to the previous season 2014 (grey bars). The first two localities are gravel sandpits; the others are ponds. Due to extraordinary weather in summer 2015 (see text), instead of average values from two sampling dates, only the first sampling was considered.

2) Interference Analysis

Biomass

The null hypothesis was that the amount of biomass is the same on all localities. This hypothesis was rejected on a significance level α=0.05 (H=20.64, $\chi 2$=11.07). The amount of biomass differs greatly within the localities and specific locality has a big influence on the biomass production. After a simultaneous comparison of the localities on a significance level α=0.02, the same significant difference in the biomass production on all of the localities was found.

Number of Colonies

Data of this factor were the same as of the previous one. The null hypothesis that the number of the colonies is the same on all localities was rejected with the level of significance α = 0.05 (H=55.92, $\chi 2$=11.07) and with a simultaneous comparison of the localities on a significance level α = 0.02 a significant difference in the number of

colonies was found.

Average Colony Mass

The situation with this parameter is also the same as for the other parameters. That means a considerable dissimilarity between the average colony mass on the studied localities. The null hypothesis was rejected on the level of significance $\alpha = 0.05$ ($H=113.79$, $\chi 2=11.07$) as well as simultaneous comparison of the localities on a significance level $\alpha = 0.02$ found a significant difference in the average colony mass within all of the localities.

D. Conclusions

The season of 2015 varied from the previous ones primarily because of lack of colonies at the second sampling (August 2015) at three of five localities and because of a great increase of biomass on the pond Podřezaný in comparison with previous years. An explanation can be the extraordinary weather course: a period of high temperatures and drought caused an increase of trophicity in most freshwaters. The exception was a pond Podřezaný, into which less eutrophic water flows from the forest.

Preliminary statistical results showed dissimilarity of biomass production on different localities and also dissimilarity of biomass production between seasons 2015 and 2014. Study that is more detailed will be needed to correlate factors of *PM* invasive spreading within a longer time period.

III. Microbiota Associated with *Pectinatella magnifica* and Its Antimicrobial Activity

Because marine bryozoan are harbored by symbiotic bacteria which are known for the production of antimicrobial [4]–[5] and other bioactive compounds [6]–[7], there is a presumption that also freshwater *P. magnifica* may serve as a host for some specific bacterial species which may possess antimicrobial activity. Hence, the aim of our part of the study was to enumerate and isolate culturable bacteria from *PM* colonies and test their antimicrobial activity.

TABLE I
Bacterial Numbers Determined in *Pectinatella magnifica* Colonies and Water

Type of bacteria	Type of sample	No. of samples	Bacterial counts (log CFU/g or mL)	
			Varied from to	Median
Aerobic	Gelled mass	144	3.64 – 6.65	5.01
	Superficial layer	144	4.96 – 9.51	6.64
	Water	48	1.88 – 5.12	3.23
Facultative anaerobic	Gelled mass	144	3.00 – 6.26	4.53
	Superficial layer	144	4.91 – 9.20	7.51
	Water	48	1.20 – 3.63	2.42
Anaerobic	Gelled mass	144	1.00 – 6.85	3.65
	Superficial layer	144	1.74 – 7.90	4.15
	Water	48	1.00 – 2.96	1.75

A. Material and Methods

Samples of *PM* colonies and surrounding water were collected at four locations: two ponds "Hejtman" and "Kanclíř", two gravel sandpits "Cep" and "Veselí I". Three colonies from each location were collected at three different sampling times during the years 2012–2015. The superficial layer of bryozoan colonies containing zooids was collected separately from the inner gelled mass. Samples were aseptically transferred to vials containing oxygen-free peptone water, kept in a refrigerator and analyzed within 5 hours after collection. Water samples were collected into a sterile vessel and kept cold at 4 °C until analyzed.

Bacterial counts were determined by cultivation on yeast extract-tryptone agar (YT; Oxoid) supplemented with 1 g/L of glucose (yeast-tryptone-glucose agar; YTG). Samples were homogenized and serially diluted in peptone water under anaerobic conditions. One mL of appropriate dilutions was transferred to sterile Petri dishes, which were immediately filled with YTG agar. Cultivation was carried out at both, aerobic and anaerobic (Anaerobic Plus System; Oxoid) conditions at 25 °C for 3 days. Under the anaerobic condition, also facultative anaerobes were able to growth. So, for the determination of strictly anaerobic bacteria, neomycin was added to the media at a concentration 70 mg/L to avoid the growth of facultative anaerobes. After incubation, bacterial colonies were counted and data were expressed as a log CFU/g. Bacterial colonies representing a wide range of pigments and colony types were picked up from each cultivation variant, enriched in YTG medium and identified [8]. Bacteria in water samples were enumerated in triplicate using YTG agar, cultivation was performed under the same conditions as described above.

Antimicrobial activity of cell-free supernatants from *PM* associated bacteria against potential pathogens, meat-spoiling psychrophilic bacteria, intestinal bacteria and bacteria isolated from *PM* was tested by agar-well diffusion method. Cell-free culture supernatants were obtained from *Acinetobacter pitii* (2 stains), *Aeromonas veronii* (12 strains), *Aquitalea denitrificans* (10 strains), *Aquitalea magnusonii* (5 strains), *Enterobacter* sp. (3 strains), *Klebsiella* sp. (2 strains) *Lactococcus lactis* ssp. *lactis* (2 strains), *Leuconostoc pseudomesenteroides* (1 strain), *Pseudomonas* sp. (5 strains), and *Sphingomonas pituitosa* (2 strains) by microcentrifugation (18 000 x g, 4 °C, 20 min) of overnight bacterial cultures. 20 mL of nutrient agar was added to 1 mL of overnight cultures of potential pathogenic, meat-spoiling, intestinal and *PM* associated bacteria (tested strains: 5 strains of *E. coli*, 3 strains of *Salmonella* sp., 7 strains of *Clostridium* sp., 3 strains of *Lactobacillus* sp., 2 strains of *Bifidobacterium* sp., *Acinetobacter parvus* CCM7030, *Moraxella canis* CCM4590, *Pseudomonas aeruginosa* CCM1960, *Pseudomonas fluorescence* CCM2115, *Propionibacterium acnes* DSMZ183, *Serratia marcescens* DSMZ30212, *Micrococcus luteus* ATCC10240, *Listeria monocytogenes* ATCC7644, and 15 strains isolated from *PM* colonies). Plates were dispersed and agar allowed to firm. Antimicrobial tests were done under both, aerobic and anaerobic conditions and different cultivation media were used. The first one was the basic medium appropriate for each tested bacterium; the second medium was prepared from *PM* water extract, and the last one contained blood. Wells in the agars were created using a 6-mm

cork borer. Into the wells 100 μL of cell-free supernatant triplicate were pipette, plates were incubated for 10 hours in 4 °C to let supernatant diffuse to agar, and cultured 24–48 hours at appropriate temperature. Zones of inhibition were measured after cultivation.

B. Results and Discussion

Counts of culturable bacteria in *Pectinatella magnifica* colonies and the surrounding water are listed in Table I. In most cases, all three groups of bacteria were more numerous in the superficial structures of the bryozoan colonies (by one order for aerobic and anaerobic bacteria, in the case of facultative anaerobes by tree orders) compared to gelled mass. More numerous microbiota in superficial layers may be expected because this part contains zooids with simple U-shaped gut that obtains nutrients by water filtration. In both structures of *Pectinatella magnifica* colonies dominated aerobic bacteria with counts one order higher than numbers of facultative anaerobes, and two orders higher than anaerobic bacteria counts. The most variable numbers were obtained after anaerobic cultivation of both structures of *PM* colonies. No trends in the bacterial numbers at each individual locality during each year were observed. It was expected that the highest bacterial counts would be present in colonies sampled from water with the highest microbial contamination, but this was true only in some cases. It was shown that number of microorganisms, in both structures of *Pectinatella magnifica*, did not correlate with the number of microorganisms in surrounding water.

Only one strain of *Pseudomonas moraviensis* 16/12 and two strains of *Aeromonas veronii* 8/12 and 12/13 showed antimicrobial activity against human faecal clostridia. *Aeromonas veronii* 12/13 inhibited also the growth of *Pseudomonas moraviensis* 16/12. Diameters of inhibition zones varied between 8 and 16 mm. Neither of tested conditions nor media affected the antimicrobial activity of tested cell-free supernatants. The growth of other strains was not inhibited by tested bacterial supernatants. Bacteria producing inhibition zones did not decreased pH of cultivation media; so their antimicrobial activity was probably caused by other compounds than acids. Bacteria are well known for the production of many different antibacterial substances. Antimicrobial activity was described for some *Aeromonas* strains [9] and *Pseudomonas fluorescence* is producer of monoxycarbolic acid class antibiotic mupirocin, a mixture of several pseudomonic acids [10], [11]. Mupirocin is effective against aerobic Gram-positive bacteria but most of the anaerobes are resistant [12]. Mupirocin is used for the treatment of skin infections, methicillin resistant *Staphylococcus aureus* and for its activity spectrum is part of cultivation media for the detection of bifidobacteria in fermented and non-fermented milk products containing bifidobacteria and lactic acid bacteria simultaneously (ISO/IDF 220:2009).

IV. Chemical Analysis of Metabolites and Toxins Related to *Pectinatella magnifica*

Little is known about chemistry of *Pectinatella magnifica.* In 1930 Morse [13] has published preliminary results about composition of the jelly-like secretion of *PM* concluding that the gel is not a collagen-like polymer but rather a true protein which, together with extreme growth rate, he has considered as an interesting case of extremely rapid synthesis of proteins. A course of biuret reaction has been similar to albumins, the gel proteins have been heat-coagulable, and in the proteins the author has confirmed amino acids of tyrosine, tryptophan and cystine. Inorganic compounds of sodium chloride, calcium and, surprisingly, no phosphorus have been confirmed. In statoblasts, the author has presumed presence of common chitin since after hydrolysis glucosamine and galactosamine have been found. Dry mass content of 0.4% has been reported, though our measurements (area Třeboňsko) showed dry mass content up to 2.2% in several samples.

A. Preparative Chromatography and Identification of Content Compounds of Pectinatella magnifica

We worked with lyophilized *PM* collected in Třeboňsko area in seasons 2009-2015 [14]. We focused on content compounds isolated and identified by methods of TLC, HPLC, GC-MS, NMR.

1) Extraction of Lyophilized *Pectinatella magnifica*, Isolation and Identification Process

The extraction procedure was carried out on a large portion of lyophilized *PM*. Firstly, 90% methanol was added to the material. The process of extraction was repeated three times for 24 hours to ensure the quality of extraction. The solvent was each time used fresh. The extract was than filtered and concentrated using rotavapor. The residual water was removed by lyophilization.

The dry extract was dissolved again in 90 % of methanol and 10 % water and was extracted using separatory funnel with hexane in overall ratio 1:1 (v/v, 3×). The combined hexane portions were evaporated to give **hexane** portion of extract. The methanol portion was concentrated using rotavapor to remove large part of methanol. The residue was diluted with water and repeated extraction with chloroform (3 × 24 h) was used to obtain combined **chloroform** portion. The water part was then three times repeatedly extracted with ethylacetate. The combined ethylacetate extracts after removing of solvent on rotavapor yielded **ethylacetate** portion. The water from residue was removed by lyophilization and later **water** portion was yielded.

All fractions obtained in described extraction procedures were analyzed using HPLC and TLC method according to the previously published procedures [15], [16]. No extracts showed significant signal when analyzed using HPLC-DAD detection, we obtained visible spots on TLC only after spraying with sulphuric acid and heating.

Isolation

Hexane and chloroform portions showing the possibility to isolate pure compounds were selected to undergo separation

using the column chromatography and preparative TLC on silica. Column chromatography was carried out on Merck silica gel 60 (particle size 0.040-0.063 mm). TLC plates of Silicagel 60 F_{254} (Merck) (UV detection at 254 and 366 nm, and spraying will sulphuric acid and heating to 100 °C, respectively) were employed. Different combinations of solvents were used to formulate the mobile phases suitable for successful isolation of content compounds. Tested were many combinations of chloroform, ethyl acetate, hexane, acetone, benzene, and ethyl acetate with addition of formic acid in ratios of 50:50, 60:40, and 80:20 (v/v). Fractions obtained by elution with selected mobile phases were collected and combined according to the similarity. Analytical HPLC was performed on Agilent 1100 apparatus equipped with a diode-array detector and Dionex Ultimate 3000 equipped with UV-Vis detector, respectively. Several Supelco Ascentis Express HPLC columns were used for analysis (RP-Amide, C18, C8, F5, Phenyl, all 10 cm × 2.1 mm, 2.7 μm).

Identification

The isolated compounds were identified using MS and NMR analysis. The MS spectra were obtained via GC-MS analysis of corresponding fractions: fused silica column HP – 5MS 30 m × 0.25 mm coated with film of polymethyl (5% phenyl) siloxane stationary phase. Temperature program: 140 °C hold time 1 min, then increase to 290 °C at a rate 10 °C/min, hold time 16 min. Injector temperature 290 °C. Carrier gas helium, linear velocity 30 cm/sec. Injection volume 1 l, splitter injection, split ratio 1:10. MS conditions: transfer line temperature 280 °C, ion source temperature 200 °C, 70eV, positive ion mode, full scan mode, mass range 50-650 mu. NMR spectra for ^{1}H and ^{13}C analysis were recorded using a Bruker Avance 400 Ultrashield spectrometer operating at a frequency of 400 MHz (^{1}H). NMR spectra were acquired in methanol-d_4 at 298 K and in DMSO-d_6 at 296 K with TMS as an internal standard. The ^{1}H- and ^{13}C-NMR chemical shifts (δ in ppm) were referenced to the signal of the solvent [3.30 ppm (^{1}H) and 49.9 ppm (^{13}C) for methanol-d_4, 2.49 ppm (^{1}H) and 53.6 ppm (^{13}C) for DMSO-d_6]. The 1D NMR experiment and 2D NMR experiments (COSY, HMBC, and HSQC, NOESY and TOCSY) were used to assign the individual ^{1}H and ^{13}C resonances.

2) Results and Discussion

Two groups of chemical compounds were isolated by above described chromatographic procedures from the hexane fractions, and later identified using spectral methods: i/ derivatives of fatty acids: myristic acid, pentadecanoic acid, palmitic acid, margaric acid, stearic acid, ii/ derivatives of sterols: campesterol, cholesterol, stigmasterol, crinosterol, 7-oxo-sterol.

To isolate other content compounds represented by small molecular substances, we used, similarly to previous experiments, column chromatography, preparative TLC and semipreparative HPLC. TLC on silica was used to choose a mobile phase suitable for separation with sufficient resolution of selected spots. The TLCs were analyzed using UV and visible light or combination of this with detection with sulphuric acid. Extracts and fractions were analyzed using several HPLC methods. We used mobile phase for reversed phase chromatography composed of inorganic solvent (water, formic acid, ammonia) and organic solvent (methanol or acetonitrile) with different stationary phase types (C18, RP-amide, C8). The detection was based on UV, Vis or ELSD detection.

A sequence of methods, which is commonly successful for obtaining small molecular secondary metabolites from natural material, was adopted, but unfortunately without any significant yield of pure substance in amount suitable for the identification and evaluation of biological activity. There are four main hypotheses, which can explain the lack of success of the isolation: 1) in general *P. magnifica* does not produce substantial amounts (below our limits of detection) of secondary metabolites; 2) because the mass of *P. magnifica* is mainly formed from a water rich gel matrix, which is not involved in production of content compounds, the amount of extractible compounds from the material obtained by lyophilization is too low in comparison with extracts obtained typically from natural material (e. g. plants); 3) characteristic compounds present in *P. magnifica* are unstable and conditions used for lyophilization and/or extraction can cause their decomposition; 4) the content compounds produced by *P. magnifica* are of completely different character (e. g. proteins) and thus they are not extractable/detectable by the methods applied.

B. Determination of Cyanobacterial Toxins in P. magnifica by HPLC

Cyanobacteria were found in the *PM* colony gel (typically of genus *Pseudanabaena, Komvophoron, Phormidium, Leptolyngbya*) [17]. Their number increases with the colony lifetime as often indicated by the gel colour.

Microcystins (MCs) and nodularins (NODs), hepatotoxins belonging to a diverse group of cyclic oligopeptides produced by cyanobacteria, where they have been confirmed and determined [18], [19]. Over the last few decades, MCs and NODs have become a serious ecological and health issue due to the massive cyanobacterial water blooms that have developed in eutrophied waters worldwide [18]. The toxicity of and risks from some MC variants have been studied in detail [20], [21], and the World Health Organization recommends a provisional guideline 0.001 mg/L of MC-LR for drinking waters [22]. Therefore, we adapted a published HPLC method [18], [19] in order to monitor these highly toxic compounds.

1) Experimental (Chemical and Methods)

Microcystin-LR, microcystin-RR and NOD were purchased from DHI LAB Products (Hørsholm, Denmark). Acetonitrile, water and methanol of HPLC grade and also formic acid were purchased from Sigma-Aldrich (St. Louis, MO, USA). HPLC system was Dionex Ultimate 3000 (Dionex, USA).

Samples were lyophilized biomass from seasons 2009-2014 collected in Třeboňsko area. Each sample was ultrasonicated

for 15 minutes in a water-methanol mixture 1:1 [18], 10 minutes centrifuged and then filtrated (0.45 μm filter) into an HPLC vial.

2) Results

The results of the method transfer are shown in Table II. Typical chromatogram of a mixture of standards is shown in Fig. 2.

TABLE II
EXPERIMENTAL CONDITIONS OF THE ORIGINAL AND TRANSFERRED HPLC METHODS

	Babica *et al.* [18] Blahová *et al.* [19]	This paper
Stationary phase	Supelcosil ABZ+Plus 150x4.6 mm, 5 μm	Ascentis Express RP-amide, 150x2.1 mm, 3 μm
Mobile phase	acetonitrile+TFA*/ water+TFA, flowrate 1.0 mL/min, 30°C	acetonitrile+FA** / water+FA, flowrate 0.5 mL/min, 25°C
Gradient time	30 min	18 min
Detection	UV 238 nm	UV 240 nm
LOD	0.02 mg/kg dry mass	1.3 mg/kg dry mass
Retention time of MCs	11-17 min	3-6 min

* TFA = 0.1% trifluoracetic acid
** FA = 0.1% formic acid

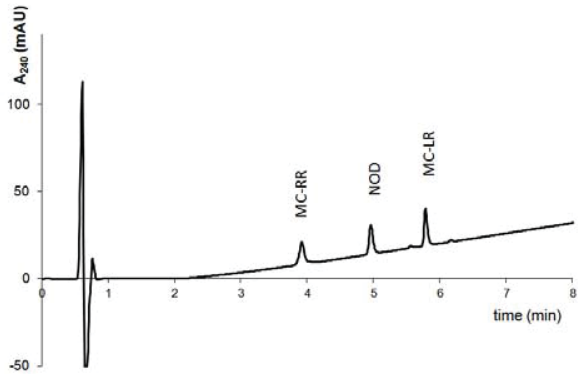

Fig. 2 Chromatogram of a standard mixture of nodularin (NOD) and microcystins RR (MC-RR) and microcystin-LR (MC-LR). The drifting baseline for given wavelength (240 nm) is due to gradient elution. For experimental conditions, see Table II, the rightmost column

3) Estimation of a "Real" LOD on a Model Case of Veselí I

The way of sample preparation (lyophilization of *PM* biomass) means that the calculated LOD relates to a dry mass of *PM*. However, this value does not show a real concentration of the toxins in the water reservoirs.

We tried to estimate LOD in the water (real environment) on a model reservoir with average production of biomass (Veselí I). This number is also a threshold concentration in water that could be determined by the method analyzing dry mass of *PM* after calculation with total water volume of the pond and also to the water volume around the pond bank.

Let us approximate the reservoir with a spherical cap having surface area 240,000 m^2, i.e. periphery of the circle is 1,750 m, radius of 275 m, maximum depth 4.5 m (average depth 3.5 m), and volume of 540,000 m^3. *PM* usually appears within 5 m from the pond bank. Within a strip (transect) of 10 m (i.e. 50 m^2), 30 kg of fresh biomass was collected. Thus, considering the whole periphery, there is 5,250 kg of fresh biomass in the reservoir. If 99% of it is water, we get the amount 52.5 kg of dry mass per 540,000 m^3 of water.

LOD was determined as 1.3 mg/kg of dry matter, which corresponds to 70 mg of toxins per 540,000 m^3, which is equivalent to 0.13 ng/L in water.

We can also estimate a maximum threshold concentration of toxins with the outer circle 5 m from the bank in depth of 1 m (the typical occurrence of *PM*): the volume of water is 8,600 m^3, thus the concentration in water will be 8.2 ng/L.

C. Mupirocin Occurrence in Bacteria Related to Pectinatella magnifica

Mupirocin (Bactroban or Centany) is an antibiotic of the monoxycarbolic acid class. It was originally isolated from *Pseudomonas fluorescens* NCIMB 10586 [10]. Mupirocin is bacteriostatic at low concentrations and bactericidal at high concentrations. It is used topically and is effective against Gram-positive bacteria, including methicillin-resistant *Staphylococcus aureus* (MRSA). It is known that mupirocin is a mixture of several pseudomonic acids [23]. To confirm mupirocin in the samples, an HPLC method [23] was adapted to our conditions.

1) Samples

Supernatants and supernatant dry matters samples were prepared parallely from both *Aeromonas* sp. and *Pseudomonas moraviensis* strains (see *A*, Section III) to be analyzed for presence of bioactive mupirocin. The supernatant dry matter obtained by lyophilization was extracted by methanol. In methanol insoluble portion was treated separately (2x2 samples). The methanol portion was subsequently extracted using separatory funnel to obtain hexane, chloroform, ethyl acetate, and water parts, similarly to *P. magnifica* biomass processing (2x4 samples) (see *A* 1, Section IV).

2) Experimental

Column was Supelcosil LC-8 (Supelco), 5 μm, 150 x 4 mm, mobile phase was acetonitrile with buffer (100 mM ammonium acetate adjusted with acetic acid to pH=4.0), detection @240 nm, flowrate was 1 mL/min, temperature was 25°C. Solvents of HPLC grade, ammonium acetate and acetic acid were purchased from Sigma-Aldrich (St. Louis, MO, USA). Mupirocin was purchased from Applichem (Darmstadt, Germany) No. A4718 (90%).

3) Results

The experimental parameters of the adapted method were optimized as follows: the chromatographic column was Supelcosil LC-8, 150x4 mm, 5 μm; two mobile phases were used – i/ for isocratic elution of the mupirocin standard (70% acetonitrile with 30% of 100 mM ammonium acetate buffer, pH=4.0), ii/ for gradient elution of samples of bacteria extracts (10–60% of acetonitrile in 25 minutes with the same buffer). The flowrate was 1.0 mL/min, temperature was 25°C, UV-detection @240 nm. Estimated LOD was 0.2 mg/L. Applying

the optimized method isocratic method (run time of 11 minutes, retention time of mupirocin=pseudomonic acid A was 10 min) we confirmed that the commercial substance mupirocin is not a chromatographically pure compound (two extra peaks at 6.5 min and 7.5 min separated with resolution 1.0). In all the samples analyzed, mupirocin was below LOD.

D.Cytotoxicity of Extracts from Pectinatella magnifica

The main aim of the project is to assess potential toxicity of environment invaded by *PM*. Although there is not yet a particular toxic compound related to *PM* occurrence, fractions of lyophilized biomass of *PM* were tested for cytotoxicity.

1) Materials and Methods

Pectinatella magnifica extracts for *in vitro* tests were prepared and supplied by the Department of Natural Drugs, Faculty of Pharmacy, University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic (see *A1*, Section IV). For the purpose of cytotoxicity evaluation, we used THP-1 cell line (European Collection of Cell Cultures, Salisbury, UK), cultured in RPMI 1640 medium (Verviers, Belgium) supplemented with 10% fetal bovine serum, 2% L-glutamine, 1% penicillin and streptomycin at 37 °C with 5% carbon dioxide. All reagents were from Sigma-Aldrich (St. Louis, MO, USA).

Cytotoxicity of *PM* extracts was determined using a LDH assay kit (Roche Diagnostics, Mannheim, Germany) as described previously [24].

For 24 h the THP-1 cells were treated with a various extract concentrations ranging from 10 to 1000 µg/mL in RPMI 1640 medium (concentrations were selected according to [25]).

2) Results

For all tested extracts (PM1 – methanolic extract, PM2 – hexane fraction, PM3 – chloroform fraction, PM4 – ethylacetate fraction, PM5 – aqueous phase), the cytotoxicity was evaluated as a Relative cytotoxicity (relative to control values). Subsequently, from a dose-response curve we derived LD50 values for each of five extracts prepared from *Pectinatella magnifica*. As our results shown, cytotoxicity expressed as LD50 of the following *PM* extracts increased as follows: PM5 (250 ug/mL) > PM2 (75 ug/mL) > PM3 (40 ug/mL) > PM4 (31 ug/mL) > PM1 (29 ug/mL). According to [26] the treatment with *PM* extracts led to toxic effect on THP-1 cells, as their LD50 values were assessed to be <1000 µg/mL.

3) Conclusion

Results from the cytotoxicity assays demonstrated that extracts prepared from *Pectinatella magnifica*, exerted some toxic effect to cells *in vitro*. However, aqueous phase (PM5), which comes into consideration as the most common in nature did not show cytotoxicity. From these results, further studies on *Pectinatella magnifica* should aim its potentially negative effects to the environment.

V. Conclusions

Several points of view were examined related to invasion of *PM* in the area of Třeboňsko. Statistical analysis of *PM* biomass revealed that the invasion of *PM* (spreading to localities) is neither significantly related to a specific locality nor environment. The amount of produced *PM* biomass is very variable among localities and also years (seasons).

PM colonies examined in this study were colonized by bacteria from the environment. However, their abundance was higher than in surrounding water, so their symbiotic relationship with *PM* should not be excluded. Antimicrobial effect of three strains was demonstrated, but the substance responsible for this activity was not identified yet. Related bacterial are known for the production of antibiotic mupirocin, but its presence above LOD in our strains was not proven.

There is no apparent toxicity related to microcystins and nodularin (their concentrations are below LOD of our HPLC method), neither cytotoxicity related to aqueous extracts from *PM*.

We can conclude that the invasion of *PM* in water reservoirs of the Czech Republic does not represent a toxicity risk in this moment. However, a longer-term monitoring is needed.

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Knowledge Management as Tool for Environmental Management System Implementation in Higher Education Institutions

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***Abstract*—**The most significant changes in the characteristics of consumers have contributed to the development and adoption of methodologies and tools that enable organizations to be more competitive in the marketplace. One of these methodologies is the integration of Knowledge Management (KM) phases and Environmental Management Systems (EMS). This integration allows companies to manage and share the required knowledge for EMS adoption, from the place where it is generated to the place where it is going to be exploited. The aim of this paper is to identify the relationship between KM phases as a tool for the adoption of EMS in HEI. The methodology has a descriptive scope and a qualitative approach. It is based on a case study and a review of the literature about KM and EMS. We conducted 266 surveys to students, professors and staff at Minuto de Dios University (Colombia). Data derived from the study indicate that if a HEI wants to achieve an adequate knowledge acquisition and knowledge transfer, it must have clear goals for implementing an EMS. Also, HEI should create empowerment and training spaces for students, professors and staff. In the case study, HEI must generate alternatives that enhance spaces of knowledge appropriation. It was found that 85% of respondents have not received any training from HEI about EMS. 88% of respondents believe that the actions taken by the university are not efficient to knowledge transfer in order to develop an EMS.

***Keywords*—**Environmental management systems, higher education institutions, knowledge management. training.

I. Introduction

THERE is a growing preference for the acquisition of goods and services that are environmentally friendly. This implies the fulfillment of a number of stages like identification, mitigation and treatment of environmental impacts. Those impacts are generated by several productive and service activities that use natural resources.

Consumer actions are also influenced by the process of organizational decision-making. The process must ensure an inclusive corporate environmental culture where every stakeholder of the company has a key role. Companies must develop communication mechanisms that facilitate knowledge transfer, knowledge exchange and knowledge access. This knowledge is required to develop activities in a sustainable way. It is based on a coordination mechanism between economic, social and environmental aspects.

HEIs act as agencies responsible of teaching processes. They must generate professional, social and sustainable opportunities for comprehensive training of human beings [1]. These processes will only have effect if institutional knowledge is properly managed. Institutional knowledge consists of academia, culture, creativity and experience of each stakeholder.

HEIs should coordinate environmental management and KM. Also knowledge transfer facilitates empowerment and learning from the different stakeholders about strategies that must run for prevention, correction and mitigation of environmental impacts. Environmental impacts are produced in compliance with the missionary activities (Teaching, research and extension).

The rest of the paper is as follows: In the next section KM, EMS and the interaction between both of them are described. In the next section, the methodology is presented. Then the results of the study will be addressed. Finally, the respective findings of the research will be given.

II. Knowledge Management

It is considered that KM was born as a study area in 1990 resulting from developments in information technology and computing, the development of types of consulting and promotional campaign at conferences [2]. Moreover, the uncertainty conditions and constant changes on markets characteristics demanded the exchange of knowledge among all individuals and external stakeholders on an organization [3]. This allowed the development of KM in order to improve communication between individuals, document management, coverage of customer requirements, quality and organizational culture [4].

KM is the ability of individuals in a company to understand and use business information through the use of technology and knowledge transfer [5]. KM also coordinates a variety of data and information in order to encourage innovation and creativity of individuals [6]. Similarly, KM facilitates business management from the use of applications, processes and technologies [7]. At the same time, the main purpose of KM is to enhance the knowledge transfer from those who have it to the other members of the company who require it to meet its tasks efficiently. Therefore businesses require a correct communication platform to provide knowledge transfer either directly or indirectly [8]. However, there are some obstacles that restrict KM process such as information access, corporate hierarchical structure, governance, the secret as a cultural component and the fear of long periods of implementation [9].

In order to understand the concept of KM is critical to

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understand the terms of tacit and explicit knowledge. These terms should be used together to perform a holistic KM. Those statements are going to be discussed below.

A. Tacit and Explicit Knowledge

Tacit knowledge is acquired by performing daily tasks, but usually people are not aware of what they are learning [10]. Tacit knowledge is part of practical intelligence that is the individual's ability to learn from experience and replicate that knowledge in the acquisition of personal goals. Tacit knowledge is not codified. It is characterized by the know-how gained in formally through learning guidelines and procedures. It is not associated with specific research, technical or training programs [11]. In addition, tacit knowledge is manifested from the observation of the activities carried out by experts, learning and training, and learning by doing processes. However, the term of tacit knowledge has expressed some ambiguities [12]: It is both individual and group. It is obtained through experience even though it is innately in people. It can be obtained by contact with other individuals or not. It can develop behavioral routines. It always promotes innovation. It can be transformed into explicit knowledge or not.

Explicit knowledge is formal and systematic. It can be achieved through reading projects, equipment manuals and discussion [13]. It can easily be collected, documented, stored and retrieved independently of any individual through the media and technological systems [14]. In addition, explicit knowledge can be communicated, understood and shared without the presence of a subject or individual. It is easy to transmit and communicate through logical deductions and formal study [15].

B. KM Models

Nonaka and Takeuchi developed one of the most outstanding KM models. It is called SECI model which is comprised of four elements: Socialization, externalization, combination and internalization [16]. Socialization can transmit the new tacit knowledge by communicating experiences. Externalization formalizes the knowledge that is available to other individuals. Combination transforms explicit knowledge into more complex and systematic elements. Internalization added explicit knowledge into tacit knowledge that can be addressed by the individual again. However, this model has presented some detractors because it uses factors and variables that hinder the measurement of knowledge creation process [17]. It is a model that is based on the intuition that does not show a clear method study[18]. Combination and internalization phases are not clearly described and they include typologies that have not been demonstrated [19]. The overall process of knowledge creation is unclear because it is not clear who generates it [20].

Other models that describe business needs in a better way had been generated. The KIKI model has a customer-oriented view and it is based on collaboration, service characterization, training and knowledge implementation through new service ideas [21]. The knowledge transfer and creation model presents a coordination mechanism of tacit and explicit knowledge. Its dissemination throughout the company takes place in four different stages: Individual, small groups, organization and external stakeholders [22].

The model of KPMG Consulting Group proposes knowledge unification in a complex hierarchical system of distribution, culture, leadership, learning elements, ability of individuals and teamwork. This happens from the use of elements that facilitate learning ability of the companies [23]. The company based on the information model presents three strategies that can be performed within companies [24]: First enterprises must converts information in clear and precise indicators. Then companies have to optimize business areas by removing or transforming those areas where is data repetition. Also the model presents project management in a way that the work is divided into specific tasks. At the same time, there is a model that brings together holistically phases of KM: Exploration and exploitation [25], [26]. The first is made up of acquisition, socialization, externalization, combination and internalization of knowledge. Meanwhile, these consider its integration, transfer and storage.

III. Environmental Management Systems

There is growing interest in companies to generate actions aimed to implement sustainable business activities. These should be documented and transferred to all members of the organization. Therefore, the EMS were created. These include a number of business processes that were developed to achieve corporate goals. These ensure a proper use of natural resources and an effective treatment of adverse effects produced on the environment.

An EMS is a set of regulations in an organization in which policy interface is implemented. Mechanisms of planning and implementing actions to protect and improve the environment and the company itself are also generated [27]. The EMS are closely related to quality management systems and they are part of a systemic process and continuous improvement. They facilitate corrective actions and improvement of the impacts on the environment [28].

The International Organization for Standardization (ISO) developed an international standard that allows all kinds of organizations to design procedures that can help companies to anticipate environmental impacts and improve their behavior at an environmental level. Those procedures are called ISO 14000. The 2015 version provides organizations with a practical policy to promote environmental protection for the specific context in which each business operates. Among the most important changes is carrying out these assessments from the perspective of life-cycle assessment [29].

There are a set of common practices among some business when they are implementing a new EMS [30]. First of all, if companies do not have a specialized team in the implementation of EMS, managers tend to implement actions to mitigate environmental impacts in an empirical way. Secondly if companies have a formalized EMS, managers often do not know what to do with the results. For this reason, they waste processes and learning curves.

The United Nations Industrial Development Organization (UNIDO) proposed the Transfer of Environmentally Sound Technology (TEST) that is divided into three basic principles [31]. First, it has a preventive approach to ensure clean production processes. Secondly, this approach has to be managed properly and involve all stakeholders. Finally, corporate strategy must have social responsibility policies that facilitate the adoption of sustainable business strategies. For all this, UNIDO proposes combining TEST methodology with EMS, in accordance with the guidelines established the ISO 14000 standard.

A. Environmental Certifications

Environmental certifications were introduced as tools that allow companies to organize their internal management taking into account their environmental impacts and the measures to prevent and reduce them. Standards accepted by the academic and business community in terms of HEIs are: "Eco Management and Audit Scheme (EMA)" [32] and ISO 14001 [29]. However, there are some differences between both standards (see Table I).

TABLE I
MAIN DIFFERENCES BETWEEN ISO 14001 AND EMAS REGULATION

ISO 14001	EMAS
International	European Union
Technical standard	European Regulation
Imposes a commitment to implement current legislation	It requires companies to full compliance with current legislation
Audits in order to check compliance with the requirements through an accredited institution	It requires compliance verification
Environmental initial review is recommended but not audited it	Initial environmental review is mandatory and verifiable
Design and maintenance of EMS is a manager's responsibility	It requires the active participation of employees in the design and maintenance of the EMS
The publication of environmental information is a management decision	It requires the publication of an environmental statement (Annual report) that is validated by an independent expert

Source. Own elaboration

Despite all, the interest of this research focuses on EMS that has been implemented in HEIs. This will be addressed in the next section.

B. EMS at HEIs

In this area, several outstanding alternatives have been developed. EMS applied to institutional mission processes (Teaching, research and extension) were transformed into actions that make universities sustainable institutions. EMS were no longer a physical or digital document. This was transformed into concrete actions involving all stakeholders of the institution [33].

In the United States, the first institutions interested in applying EMS in their missionary activities were: University of South Carolina, The Medical University of South Carolina and Clemson University. These organizations developed the initiative "Sustainable Universities of South Carolina" (SC-SUI) [34]. The Osnabrück University (Germany) developed the "Environmental Management Osnabrück Model for Universities". It is based on the EMAS [35].

Subsequently, a model was developed for the implementation of an EMS in all Universities and HEIs in the United States. It is based on an adaptation of the ISO 14001 and the recommendations of the US EPA [36]. In the case of Colombia, an EMS model was proposed. It takes into account the actions of each institution. It is made up of an appropriate and safe treatment of solid waste and hazardous materials [37].

Other HEIs that have implemented EMS are: Newcastle University, The University of Bristol, The University of British Columbia, and University of Bremen. In Colombia appear: Industrial University of Santander, Universidad del Valle, Universidad de los Andes, National University of Colombia, Pontifical Javeriana University, Universidad Libre de Colombia and Corporacion Universitaria Minuto de Dios.

IV. KM AND EMS

HEIs are transforming their certification processes into sustainable activities. However, this transformation requires a combination of resources and capabilities that can be tangible and intangible. Also it requires the commitment of all stakeholders of the institution. Among these resources is knowledge with its tacit and explicit components. HEI should ensure forums for participation, communication and learning among different stakeholders in order to achieve sustainability. The required knowledge in the implementation of an EMS is [38], [39]: Policies, regulations and environmental certifications; environmental knowledge and skills to manage knowledge. Also it requires methods and techniques to assess and monitor different levels of impact.

Knowledge about products, services and their impact on the environment is required. Theoretical and practical knowledge of design, integration and implementation of an EMS is required. Therefore, KM not only increases the productivity of the organization, but also improves environmental operations. HEI should establish coordination mechanisms between KM and EMS can improve technological development, management efficiency and firm performance at the same time [40]. However, EMS would be more effective, if they have more community involvement. Also, it is necessary to include tacit knowledge, creativity and culture. Besides education and training become essential elements for the development and implementation of an EMS in any institution [41].

V. METHOD

The methodology is qualitative. Also it has a descriptive approach. It is based on literature review about KM, EMS and the relationship between them. When the relationship between the components of interest was obtained, we proceeded to perform a case study at Corporación Universitaria Minuto de Dios, Seccional Bello. We carried out the primary information by designing a form. Then we conducted a survey with 266 representatives of the university community, including teachers, students and administrative staff.

The form is made up of open and closed questions. The

form is divided into four sections (see Table II).

TABLE II
CODING QUESTIONS

Codification	Chapter
PI1, PI2, PI3, PI4, PI5, PI6, PI7, PI8, PI9, PI10, PI11	Environmental management Perception in the HEI I (Actions taken by members of the academic community)
PII1, PII2, PII3, PII4, PII5, PII6	Environmental management Perception in the HEI II (Actions taken by the directors of the institution)
A1, A2, A3, A4, A5, A6	Actions to be implemented (Findings on a set of proposals that could be incorporated in the HEI)
Comments	Additional comments (Respondents can express their general assessments and proposals for implementing an EMS in HEI)

Source. Own elaboration

Secondary information was obtained through literature review in databases, Institutional Repository, files, reports and journals in the field. Then, a diagnosis was made in the HEI. It was intended to identify the very particular traits of EMS and KM. The findings are going to be presented below.

VI. RESULTS

Governance and management in HEI should be based on a set of strategies and alternatives that involve all stakeholders and missionary activities. This involvement is generated from the creation of communication between stakeholders. However, these actions are insufficient. It is necessary to generate real empowerment in all individuals.

Communication, empowerment, dialogue and involvement of all stakeholders are essential components of KM and EMS. Therefore, based on the review of the literature, common areas of interest between GC and SGA (see Table II) were obtained.

TABLE III
COMMON ASPECTS BETWEEN KM AND EMS

	KM	EMS
Culture	It facilitates learning ability in companies. It should be considered in the process of resistance to change.	It facilitates the learning capacity of the policies and requirements in terms of sustainability and environmental protection.
Creativity	It encourages innovation in individuals and company.	It encourages innovation and development of new techniques, tools and alternatives for management of renewable and nonrenewable resources.
Teamwork	It allows the exchange and transfer of data, information and knowledge.	It allows the transfer of data, information and environmental knowledge among stakeholders.
Empowerment	Organizational growth for all members based company access to decision-making.	It allows internalize and implement environmental management strategies. Also it facilitates changes in organizational culture.
Interaction and communication	Between internal and external members to meet market demands.	Among the various stakeholders to bring forward joint actions to use renewable and nonrenewable resources.
Customer orientation	It can capture and meet the requirements of customers.	---
Training	Power individual and collective learning. Promotes the correct execution of daily activities. Promotes decision making and business management.	It promotes individual and collective learning on commitments and responsibilities to implement the environmental management process.
Knowledge transfer	It generates economic value to companies.	It allows the adoption of environmental knowledge required in the EMS.
SECI	It facilitates the transfer of knowledge based on motivation, leadership and involvement of the entire hierarchical structure.	It promotes the involvement of all stakeholders in environmental management of institutions.
Knowledge storage	It retains the essential knowledge for organizational operation.	It retains the essential knowledge for organizational operation in environmental terms.
Knowledge Integration	It allows abbreviate and understand the new working methods.	It allows abbreviating and understanding the new environmental management methods.
Technological development	It can solve problems based on applied research and best practices. This improves productivity and organizational competitiveness.	It allows designing and developing tools, products and services that facilitate environmental management.
Learning curves	It improves productivity and competitiveness of individuals and organizations.	It allows controlling and monitoring of environmental knowledge required in the SGA.

Source. Own elaboration

The Corporación Universitaria Minuto de Dios has a non-formalized Environmental Management structure. This looks for the proper use of natural resources and environmental protection. This structure is led by the Administrative Group of Environmental and Health Management (GAGAS), which was reactivated in March 2016. However, the strategies adopted by the GAGAS have had little impact among members of the university.

The above information was obtained based on 266 surveys of students, professors and staff. 250 surveys were validated. For analysis was taken into account coding questions by considering their distribution in the four functional groups of the form. In the case of environmental management perception in the institution I (see Fig. 1), participants (87.2%) are taking care of natural resources and the preservation of the environment. However, they have not received training or training sessions have not been recurring, as 75.6% of respondents said.

The alternatives conducted by the case study organization have not favored individual and collective learning. These alternatives do not allow the involvement of different stakeholders in the administrative processes for the appropriate use and conservation of natural resources and the environment. This has created a general perception about the nonexistence of environmental management in the different missionary activities of the institution (teaching, research and extension).

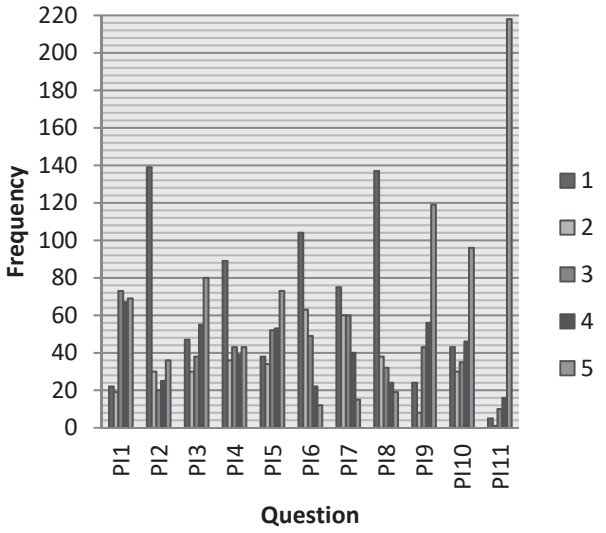

Fig. 1 Environmental management Perception in the HEI I

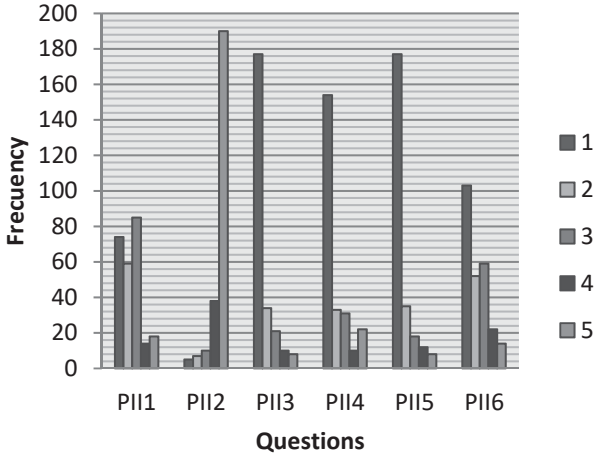

Fig. 2 Environmental management Perception in the HEI II

In section "Environmental management Perception in the HEI II" (see Fig. 2), 88% of respondents indicated that the actions taken by the institution for the knowledge transfer for environmental management have been little insufficient. For this reason, the care of the environment is not efficient. Everything should start by the visibility of GAGAS, which is little known or completely unknown for 92.8% of the participating individuals. This organizational structure will support for different strategies and alternatives that managers brought forward in environmental management. These alternatives involve all stakeholders.

Participants were also asked about their preferences for six possible actions to implement an EMS in the institution. The strategies that received better rating were (see Fig. 3): Development systems for the collection and reuse of rainwater. Generate agreements for the collection of electronic waste. Generate production projects based on recyclable material. The less acceptance campaign was single daily glass because it does not involve all stakeholders.

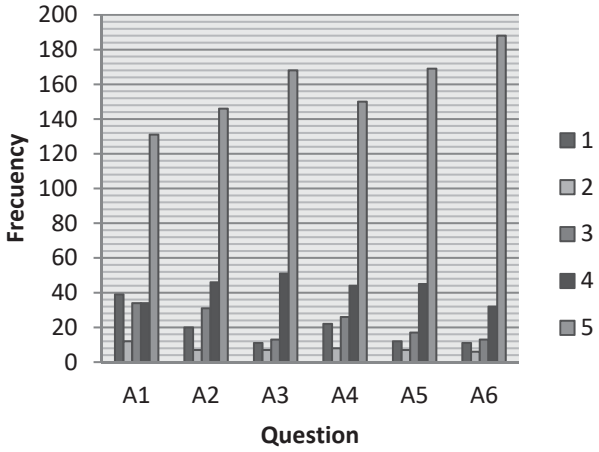

Fig. 3 Actions to be implemented

A space for additional comments was also provided. The most frequent comments were: Uniminuto has to promote and transmit the whole environmental activities to all stakeholders. Also, Uniminuto has to carry out training and communication campaigns. Besides Uniminuto has to optimize the use of paper and water and Uniminuto should design and implement ecopoints and vertical gardens.

VII. Conclusion

KM and EMS in HEIs promote decision-making, organizational strategies adoption and internalization of new procedures by the different stakeholders. This is achieved by empowering individuals from good environmental management practices in missionary activities (Teaching, research and extension). However, this process requires monitoring and evaluation plans to the curves of individual and collective learning.

EMS also includes the management of intangible resources such as the tacit knowledge of individuals. In order to convert this tacit knowledge into explicit knowledge it is necessary to ensure collaboration opportunities, dialogue and communication, as an essential component of organizational culture. This allows a real and sustainable empowerment by different stakeholders.

It is not enough to create hierarchical structures that support the EMS in HEIs, if there is no a real commitment of organizations. EMS not only involves the standardization of procedures and the allocation of an internationally recognized certification. SGA should focus on environmental requirements and characteristics of each of the stakeholders.

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Mechanical Activation of a Waste Material Used as Cement Replacement in Soft Soil Stabilisation

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Abstract:

Waste materials or sometimes called by-product materials have been increasingly used as construction material to reduce the usage of cement in different construction projects. In the field of soil stabilisation, waste materials such as pulverised fuel ash (PFA), biomass fly ash (BFA), sewage sludge ash (SSA), etc., have been used since 1960s in last century. In this study, a particular type of a waste material (WM) was used in soft soil stabilisation as a cement replacement, as well as, the effect of mechanical activation, using grinding, on the performance of this WM was also investigated. The WM used in this study is a by-product resulted from the incineration processes between 1000 and 1200^{o}c in domestic power generation plant using a fluidized bed combustion system. The stabilised soil in this study was an intermediate plasticity silty clayey soil with medium organic matter content. The experimental works were conducted first to find the optimum content of WM by carrying out Atterberg limits and unconfined compressive strength (UCS) tests on soil samples contained (0, 3, 6, 9, 12, and 15%) of WM by the dry weight of soil. The UCS test was carried out on specimens provided to different curing periods (zero, 7, 14, and 28 days). Moreover, the optimum percentage of the WM was subject to different periods of grinding (10, 20, 30, 40mins) using mortar and pestle grinder to find the effect of grinding and its optimum time by conducting UCS test. The results indicated that the WM used in this study improved the physical properties of the soft soil where the index of plasticity (IP) was decreased significantly from 21 to 13.10 with 15% of WM. Meanwhile, the results of UCS test indicated that 12% of WM was the optimum and this percentage developed the UCS value from 202kPa to 700kPa for 28 days cured samples. Along with the time of grinding, the results revealed that 10 minutes of grinding was the best for mechanical activation for the WM used in this study.

Keywords: Soft soil stabilisation, waste materials, grinding, and unconfined compressive strength.

Numerical Simulation of Kangimi Reservoir Sedimentation, Kaduna State, Nigeria

Abdurrasheed Sa'id, Abubakar Isma'il, Waheed Alayande

Abstract—This study focused on carrying out numerical simulations of Kangimi reservoir sedimentation by reviewing different numerical sediment transport models, and GSTARS3 was selected. The model was developed using the 1977 data. It was calibrated by simulating the 2012 profile and sediment deposition and compared with 2012 hydrographic survey results of NWRI. The model was validated by simulating the 2016 deposition and compared the results with NWRI estimates. Also, the performance of the proposed model was tested using statistical parameters such as MSE (Mean Square Error), MAPE (Mean Average Percentage Error) and R2 (Coefficient of determination) with values of 1.32m, 0.17% and 0.914 respectively which shows strong agreement. After the calibration, validation and performance testing the model was used to simulate the 2032 and 2062 profiles and deposition. The results showed that by 2032 the reservoir will be silted by 25.34MCM or 43.3% of the design capacity and 60.7% of the capacity by the year 2062. A number of sedimentation mitigation measures were recommended.

Keywords—NWRI- national water resources institute, sedimentation, GSTARS3, model

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Production of Ultra-Low Temperature by the Vapor Compression Refrigeration Cycles with Environment Friendly Working Fluids

Sameh Frikha, Mohamed Salah Abid

***Abstract*---**We investigate the performance of an integrated cascade (IC) refrigeration system which uses environment friendly zeotropic mixtures. Computational calculation has been carried out by varying pressure level at the evaporator and the condenser of the system. Effects of mass flow rate of the refrigerant on the coefficient of performance (COP) are presented. We show that the integrated cascade system produces ultra-low temperatures in the evaporator by using environment friendly zeotropic mixture.

***Keywords*---**Coefficient of Performance, Environment friendly zeotropic mixture, Integrated cascade, Ultra low temperature, Vapor compression refrigeration cycles.

NOMENCLATURES

COP:	Coefficient of performance	(-)
h:	Enthalpy	(J kg^{-1})
IC:	Integrated cascade	(-)
$\dot{m}_L$:	Liquid mass flow rate	(kg s^{-1})
$\dot{m}_t$:	Total mass flow rate	(kg s^{-1})
$\dot{m}_V$:	Vapor mass flow rate	(kg s^{-1})
P:	Pressure	(Pa)
$\dot{Q}$:	Heat rate	(W)
$\overline{T}$:	Average temperature	(K)
U:	Circulation ratio	(-)
$\dot{W}$:	Compressor power	(W)
x:	Liquid composition	(-)
y :	Vapor composition	(-)
Z:	Initial composition	(-)
y-x :	Difference in composition	(-)

Greek Symbols

ΔT_{bp}:	Difference between the boiling point temperatures
ΔT_r:	The refrigerant temperature glides (difference between dew point and bubble point) in the heat exchanger

Subscripts

B:	Bottle
C:	Condenser
Cp:	Compressor
E :	Evaporator
E-C:	Evapo-condenser
H:	Height
L:	Low
V:	Valve

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I. INTRODUCTION

A worldwide interest is considered to develop low cost vapor compression systems at cryogenic refrigeration. It consists to the integrated cascade system that can reach temperatures as low as -200°C in a single stage, with acceptable pressure ratio, using a mixture of refrigerants. These systems are also known as "auto-cascading" systems, and sometimes they are referred to as one-flow cascade or mixed refrigerant cascade systems. The refrigerant working fluid is a zeotropic mixture, normally between 2 and 5 refrigerants, with progressively low normal boiling points related to the temperature difference between the cold source and the hot sink of the considered system [1]. The specific characteristic of the zeotropic refrigerant mixtures is the occurrence of temperature pinch points in condensers and evaporators. The pinch point is due to the temperature difference between the mixture's isobaric dew points and bubble points [2]. The main characteristic of the integrated cascade (IC) system is the difference between the composition of the mixture charged into the system and the refrigerant mixture flows (liquid formed and residual vapor) through the complete cycle. The compositions of the residual vapour and liquid formed are identified at the partial condenser witch is considered as a fractional composition part with one inlet and two outlet. The range of mass composition fraction is related to the pressure and temperature levels at the partial condenser. There will be three different compositions of the working fluid of the IC system, the vapor charged with composition z, the liquid formed at the condenser enriched with the lowest volatile component with composition x and the residual vapor enriched with the more volatile component with composition y. A little range of works has been concerned by the performances investigation of IC cycles with or without phase separators [1], [3]-[13]. Missimer [1] presented a brief history of auto-cascading systems. He described auto-refrigerating cascade systems converted from a multi-component zeotropic CFCs working fluid to a CFC free mixture. Clodic [3] presented the design of an integrated cascade system permitting the low temperature CO_2 frosting. The energy

consumption and the coefficient of performance of this refrigerating system are calculated. Dewitte [4] performed an integrated cascade system with two refrigerants. Kim and Kim [5] investigated the performance of an auto-cascade refrigeration system using zeotropic refrigerant mixtures of R744/R134a and R744/R290. The effect of the high-boiling component mass fraction, on the cooling capacity, the compressor power and the coefficient of performance (COP) of the cycle are presented. It was found that the agreement between the theory and experiment was perfect and that the auto-cascade refrigeration cycle has a merit of low operating pressure as low as that in a conventional vapour compression refrigeration cycle. In our precedent works, a performance analysis of combined refrigeration cycles was established [6], [7]. Indeed, we presented a theoretical survey, which was based on finite time thermodynamic (FTT) analysis. The operating performance of two different combined vapor compression cooling cycles, the conventional cascade (CC) and the integrated cascade (IC), was investigated. It was founded that, at fixed condensing and evaporating temperatures and for same intermediate heat-exchanger temperature ratio, the IC is more efficient than the CC system. Q. Wang et al. [8] proposed a new approach to investigate the performance of a single-stage auto-cascade refrigerator operating with two vapor–liquid separators and environmentally benign binary refrigerants. They show that the main factors affecting COP are the pressure ratio and the composition of mixed refrigerants. Three stage auto refrigerating cascade (ARC) system was studied by [9]. The zeotropic mixture of environment friendly refrigerants (HC's and HFC's) was studied using two combinations (R290/R23/ R14, R1270/R170/R14). Several performances of the system among them the Coefficient of Performance (COP), exergy lost and exergic efficiency were investigated for different mass fractions in order to verify the effect of mass fraction on them. G. Yan et al. [10] proposed an internal auto-cascade refrigeration cycle (IARC) operating with the zeotropic mixture of R290/R600a or R290/R600 for domestic refrigerator-freezers. Performances of the IARC are evaluated by using a developed mathematical model, and then compared with that of the conventional refrigeration cycle. Zhang et al. [11] proposed a small-sized auto-cascade refrigeration cycle using CO_2/propane as refrigerant. The effect of fractionation heat exchanger on the performance of the cycle was analyzed. The theoretical results are compared with the experimental data which validates the precision of numerical simulation. X. Xu et al. [12] investigated theoretically and experimentally the effect of throttle valves opening on the working refrigerant composition of auto-cascade refrigeration system. The variation of refrigerant composition under different valves opening was obtained. A new ejector enhanced auto-cascade refrigeration cycle (EARC) using R134a/R23 refrigerant mixture is proposed in [13]. The performance of the EARC and the basic auto-cascade refrigeration cycles is compared by the simulation method, in terms of energetic and exergy aspects.

This paper reports the modelling of an integrated cascade (IC) system. Heat and materiel balances are developed for the considered cycle. Then, the performance investigation of an integrated cascade refrigeration system using refrigerant mixtures of R744/R134a, R23/134a, and R170/R290 is presented. The study of the coefficient of performance of the IC system for an operating point source/sink (-60°C/20°C) is presented.

II. A Two Stage Vapor Compression Plant with Environment Friendly Zeotropic Mixtures

The integrated cascade (Fig. 1) is similar to the conventional cascade system.

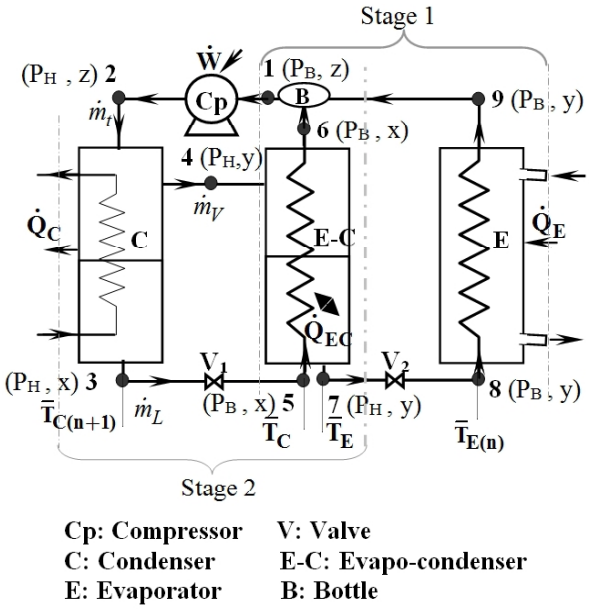

Fig. 1 Integrated cascade system with two stages

The IC system is divided into two stages and the number of stages is related to the temperature difference between the cold source and the hot sink. Fig. 1 illustrates an integrated cascade with two fluids. The integrated cascade architecture is composed by six elementary components which are: a compressor Cp, an evaporator E, a partial condenser C, an evapo-condenser E-C (the main component), a Freezer B, and tow throttling valves V_1 and V_2.

An example of binary fluid (R23/R134a) integrated cascade cycle is represented, in Fig. 2, by a temperature- composition diagram for the most volatile pure fluid.

An important integrated cascade (IC) system characteristic, which must not be overlooked, is the difference between the composition of the mixture charged into the system and the refrigerant mixture flows through the complete circuit.

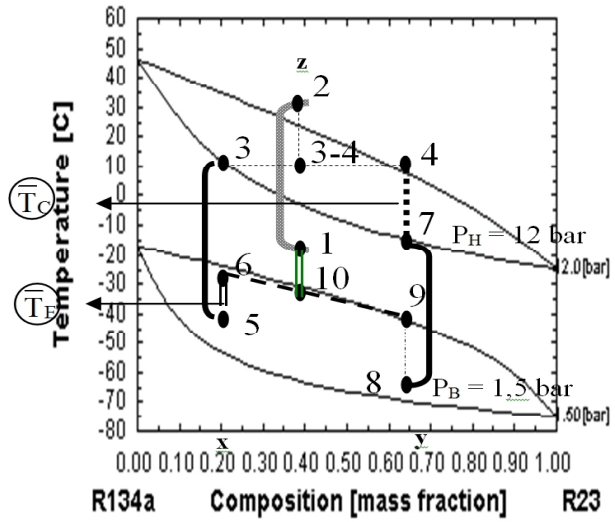

Fig. 2 Representation of an integrated cascade cycle by a T-x diagram using the R23/R134a mixture. (10→1 Freezer, 3→5 and 7→8 Trotting valve, 8→9 Evaporator, 5→6 Evapo-condenseur (Evaporation), 4→7 Evapo-condenser (Condensation), 6→10 and 9→10 Bottle, 1→2 Compressor, 3→3-4 and 4→3-4 Condenser)

III. Integrated Cascade Cycle Simulation

The refrigerated efficiency of a bi-fluid IC system COP is defined as:

$$COP = \frac{\dot{Q}_B + \dot{Q}_E}{\dot{W}} \quad (1)$$

Another important parameter for the IC working is the circulation ratio:

$$U = \frac{\dot{m}_V}{\dot{m}_t} \quad (2)$$

Expressions of U and COP have been established by matter and energy balances applied on the quasi-totality of the IC cycle components. These balances and the necessary relations for the calculation are summed up in Table I.

Table I shows that the COP expression depends on the specific refrigerating effect and circulation ratio. The behavior of the COP is analyzed billow.

IV. Numerical Appreciation

A. Working Conditions and IC Characteristics

The binary zeotropic fluid is supposed evolving between the source temperature -60°C and the sink temperature 20°C.

The working conditions of the IC (refrigerated power, COP, intermediated heat exchanger temperatures, etc) depend on the following parameters:

- Average condensing temperature of the evapo-condenser,
- Average evaporating temperature of the evapo-condenser,
- Nature and composition of the refrigeration mixture.

The influence of these parameters on working conditions of the IC system is developed subsequently in next paragraph.

B. Simulation Results of the Integrated Cascade Operation

The simulation results of an integrated cascade with three different mixtures R744/R134a, R23/R134a, and R170/R290 are shown in Figs. 3-5. Thermodynamic properties were computed using the database NIST REFPROP 6.01 [14]. The variations of coefficient of performance (COP) are shown in Fig. 3 according to the total molar fraction of pure most volatile.

TABLE I
Energy and Matter Balances of IC System

Matter balances	
Condenser	
Global balance $\dot{m}_V + \dot{m}_L = \dot{m}_t$	(3)
Balance related the higher refrigerant $y\,\dot{m}_V + x\,\dot{m}_L = \dot{m}_t\,z$	(4)
Energy balances	
Evaporator	
Courant (8-9) $\dot{Q}_E = \dot{m}_V(h_9 - h_8)$	(5)
Bottle	
Courant (10-1) $\dot{Q}_B = \dot{m}_t(h_1 - h_{10})$	(6)
Compressor	
Courant (1-2) $\dot{W} = \dot{m}_t(h_2 - h_1)$	(7)
Evaporator-condenser	
Courant (4-5-6-7) $\frac{(y-z)}{(z-x)} = \frac{(h_4 - h_7)}{(h_6 - h_5)}$	(8)
Circulation ratio	
$U = \frac{(z-x)}{(y-x)}$	(9)
Coefficient of performance	
$COP = \frac{(z-x)}{(y-x)}\frac{(h_9 - h_8)}{(h_2 - h_1)}$	(10)

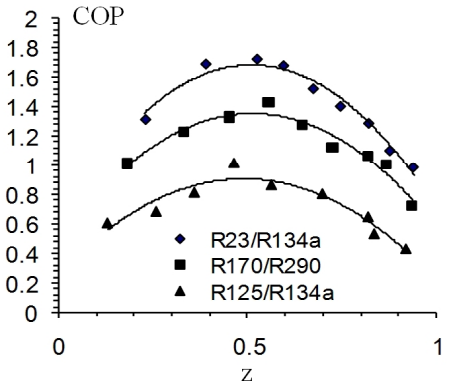

Fig. 3 Variations of the coefficient of performance (COP) with composition z for three binary mixtures R744/R134a, R23/R134a and R170/R290 at T_L=-60°C and T_H=20°C.

Table II presents the maximum COP values for three different binary mixtures. It shows that maximum COP is

reached at nearly equal concentration of both fluids. The performed refrigerant mixture is R744/R134a which has the high boiling point temperature difference and the greatest difference in composition (y-x) in the partial condenser. The performance of the evapo-condenser heat exchanger is qualitatively measured by the difference ($\overline{T}_C - \overline{T}_E$) which must be low to improve the efficiency.

Variations of COP are shown in Fig. 3 according to the total mass fraction of the more volatile component. Fig. 3 and Table II show that the binary mixtures studied can be classified into two categories:

(a) The first category includes mixtures with a high glide ΔT_r (strongly zeotrope): R23/R134a and R170/R290. The maximum COP of the IC system is obtained with the refrigerant mixture R23/R134a. This COP_{max} reaches 1.722 with initial composition z of 0.526 as showing in Fig. 3 and Table II. Whereas with the refrigerant mixture R170/R290 the COP_{max} (1.431) is obtained for a composition z of 0.556 in R170.

(b) The second category consists of slightly zeotropic mixtures (low glide temperature ΔT_r). Fig. 3 shows that the mixture formed from 50% of R125 and 50% of R134a leads to the maximum coefficient of performance of 1.012.

TABLE II
VALUES OF COP_{MAX} FOR THE THREE DIFFERENT BINARY MIXTURES

Binary mixtures	ΔT_{bp} [K]	ΔT_r [K]	z	x	$\overline{T}_C - \overline{T}_E$ [K]	(y-x) max	COP max
R23/R134a	56,03	27	0,526	0,348	9,5	0,405	1,722
R170/R290	46,51	18	0,556	0,353	28,5	0,311	1,431
R125/R134a	22,07	3.4	0,464	0,612	55,5	0,128	1,012

The working of the integrated cascade is studied for three types of mixtures for different conditions (T, P, x). The results indicate that for the three binary mixtures the maximum value of COP is reached approximately at the maximum difference in composition between the vapor and liquid phases in partial condenser (y-x). Table II shows that the maximum value of the COP system R23/R134a is reached for a total composition of about 0.526. This feature of COP due to the minimum compression ratio ($R_p=P_{aval}/P_{amont}$) is not reached for the maximum value of (y-x), but it is reached for a value of (y-x) slightly below the maximum value (Fig. 4).

C. Influence of the Zeotropic Mixture Composition on the Occurrence of Pinch Point

The temperature distribution patterns in the evapo-condenser according to the total composition for refrigeration systems R23/R134a and R170/R290 are presented in Fig. 5.

Fig. 5 shows that the temperature profile in the intermediate heat exchanger is strongly influenced by the composition of the mixture. The pinch point at the evapo-condenser is lower with R23/R134a mixture than with the R170/R290 one. For both systems the pinch point (minimum $\overline{T}_C - \overline{T}_E$) is obtained with nearly equal concentrations of both fluids.

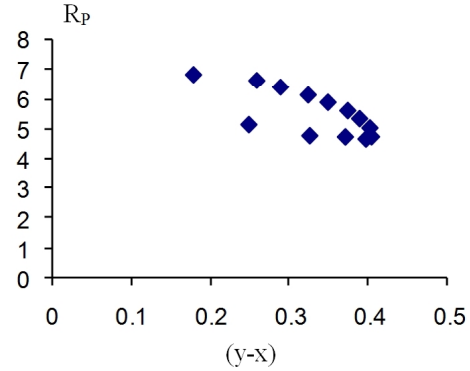

Fig. 4 Variation of compression ratio R_p versus the difference in composition (y-x) for R23/R134a system

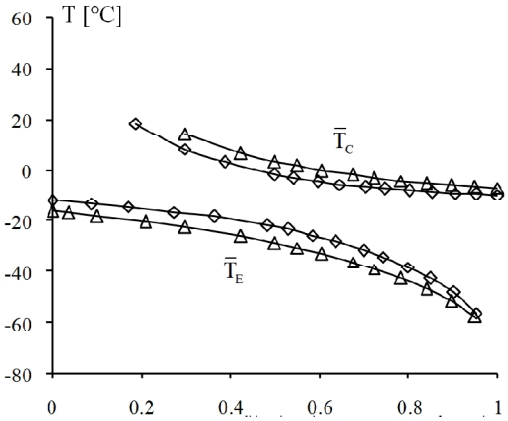

Fig. 5 Temperature profile in the E-C as a function of the total composition (z) for refrigerant mixtures: (◊) R23/R134a and (Δ) R170/R290

IV. CONCLUSION

The integrated cascade system is modeled from the mass and energy balances. This model leads to the coefficient of performance and to the simulation of integrated cascade cycle. We simulated the working of the integrated cascade system by varying the liquid composition at constant temperatures of condensation and evaporation for three refrigerant mixtures (R23/R134a), (R170/R290) and (R125/R134a). This study shows that the most efficient mixture is R23/R134a which has a large boiling point temperature difference with highest temperature glide. The efficient (R23/R134a) system conditions are reached with important partial separation composition (y-x) and lowest intermediate temperature difference at the evapo-condenser. The maximum coefficient of performance is obtained when (y-x) is approximately maximum and with a total composition z of around 0.5. The minimum temperature difference in the Evapo-Condenser is obtained with nearly equal concentrations of the two concerned mixture components. The study of the glide matching (minimization of the temperature difference) of the zeotropic mixtures in the condenser and evaporator of the integrated cascade cycle is therefore necessary to improve the performance of this cycle. This work is under way.

ACKNOWLEDGMENTS

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Solids and nutrient loads exported by preserved and impacted low-order streams: a comparison among water bodies in different latitudes in Brazil

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***Abstract*—** Estimating the relative contribution of nonpoint or point sources of pollution in low-orders streams is an important tool for the water resources management. The location of headwaters in areas with anthropogenic impacts from urbanization and agriculture is a common scenario in developing countries. This condition can lead to conflicts among different water users and compromise ecosystem services. Water pollution also contributes to exporting organic loads to downstream areas, including higher order rivers. The purpose of this research is to preliminarily assess nutrients and solids loads exported by water bodies located in watersheds with different types of land uses in São Carlos - SP (Latitude. -22.0087; Longitude. -47.8909) and Caxias do Sul - RS (Latitude. -29.1634, Longitude. -51.1796), Brazil, using regression analysis. The variables analyzed in this study were Total Kjeldahl Nitrogen (TKN), Nitrate (NO3-), Total Phosphorus (TP) and Total Suspended Solids (TSS). Data were obtained in October and December 2015 for São Carlos (SC) and in November 2012 and March 2013 for Caxias do Sul (CXS). Such periods had similar weather patterns regarding precipitation and temperature. Altogether, 11 sites were divided in two groups, some classified as more pristine (SC1, SC4, SC5, SC6 and CXS2), with predominance of native forest; and others considered as impacted (SC2, SC3, CXS1, CXS3, CXS4 and CXS5), presenting larger urban and/or agricultural areas. Previous linear regression was applied for data on flow and drainage area of each site ($R^2 = 0.9741$), suggesting that the loads to be assessed had a significant relationship with the drainage areas. Thereafter, regression analysis was conducted between the drainage areas and the total loads for the two land use groups. The R^2 values were 0.070, 0.830, 0.752 e 0.455 respectively for SST, TKN, NO3- and TP loads in the more preserved areas, suggesting that the loads generated by runoff are significant in these locations. However, the respective R^2 values for sites located in impacted areas were respectively 0.488, 0.054, 0.519 e 0.059 for SST, TKN, NO3- and P loads, indicating a less important relationship between total loads and runoff as compared to the previous scenario. This study suggests three possible conclusions that will be further explored in the full text article, with more sampling sites and periods: a) in preserved areas, nonpoint sources of pollution are more significant in determining water quality in relation to the studied variables; b) the nutrient (TKN and P) loads in impacted areas may be associated with point sources such as domestic wastewater discharges with inadequate treatment levels; and c) the presence of NO3- in impacted areas can be associated to the runoff, particularly in agricultural areas, where the application of fertilizers is common at certain times of the year.

***Keywords*—** Land use, Linear regression, Point and non-point pollution sources, Streams, Water resources management.

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Sustainable Building Design for Energy Efficiency and Healthier Electromagnetic Environment

Riadh Habash, Kristina Djukic, and Gandhi Habash

Abstract— Sustainable design is one of the emerging milestones in building construction. This concept is defined as buildings that on a yearly average consume as much energy as they generate using renewable energy sources. Realization of sustainable buildings requires a wide range of technologies, systems and solutions with varying degrees of complexity and sophistication, depending upon the location and surrounding environmental conditions. This paper will address not only the role of the above technologies and solutions but will provide solutions to reduce the electromagnetic fields (EMFs) in the building as much as possible so that the occupiers can recover from electro-hyper-sensitivity, if any. The objective is to maximize energy efficiency, optimize occupant comfort, reduce dependency on the grid and provide safer and healthier EMF environment especially for hypersensitive people. Creative architectural and engineering solutions that capitalize on the design of energy efficient technologies; combined cooling, heating and power (CCHP) microgrid (MG); and EMF mitigation will be presented.

Keywords—Sustainable buildings, energy and environment, thermal modeling, electromagnetic fields and health.

1. Introduction

The building sector currently accounts for about one third of the total worldwide energy use and much of this consumption is directly attributed to building design and construction [1]. A wide array of measures have been adopted and implemented to actively promote a better energy performance of buildings, including sustainable building concept, which is a realistic solution for the mitigation of CO2 emissions. This concept is also a viable way of reducing energy use in buildings, in order to alleviate the current worldwide energy challenges of rising prices, climate change and security of supply [2].

In our environment there are electromagnetic fields (EMFs) of different frequencies and at different levels. There are electric fields (EF) and magnetic fields (MF) from transmission and distribution power lines, substations, and appliances; radiofrequency (RF) fields from wireless systems including cellular towers, smart meters, and WiFi spots. These fields when elevated due to proximity to sources or not appropriate wiring may have some health impact especially for hypersensitive people.

The increasing number of sustainable building demonstration and research projects [3–12] highlights the growing attention given to such buildings. Goals for the implementation of sustainable buildings are discussed and proposed at the international level; for example, in the USA within the Energy Independence and Security Act of 2007 (EISA 2007) and at the European level within the recast of the Directive on Energy Performance of Buildings (EPBD) adopted in May 2010. The EISA 2007 authorizes the net-zero energy commercial building initiative for all new commercial buildings by 2030. It further specifies a zero-energy target for 50% of US commercial buildings by 2040 and net zero for all U.S. commercial buildings by 2050 [13]. There are also several advanced sustainable building design standards such as Ecohomes (BRE, UK), PassivHaus (Germany), and the US Green Building Council's Leadership in Energy and Environmental Design (LEED). These standards provide different ranking criteria to evaluate energy efficiency. However, there are no specific strategies or design guidelines provided for achieving sustainable designs. Specific design guidelines and strategies are extremely important for architects or engineers to popularize sustainability.

This work discusses some aspects of design process of sustainable buildings as well as the EMF environment. Selected energy efficient techniques including heating, ventilation and air-conditioning (HVAC); lighting; combined cooling, heating and power (CCHP) microgrid (MG) with photovoltaic (PV) are integrated in the design of the building to provide additional energy and enable system design optimizations. To promote a healthier living and working environment, levels of magnetic fields around the proposed buildings have been measured and strategies to reduce levels of fields inside the building have been proposed

2. Building Envelop

The case chosen to serve in this study is an office/residential building in the city of Ottawa. The main objective of the design is to provide interior spaces with as much illumination as possible through natural daylighting, reduce system and plug loads, maximize energy efficiency, optimize occupant comfort, decrease dependency on the grid as well as providing healthy EMF environment through integrating leading-edge technologies and sustainable design strategies and beyond. The analysis of the case study was performed for one climate scenario: Ottawa (Canada), representing a climate with a cold winter. By integrating the above technologies and strategies the design offsets its dependency on the grid significantly.

There are several parameters in a building design that could be controlled to achieve low building energy consumption, including the building orientation and structure (size, layout, partition, etc.), constructions and their materials, whether or not to allow natural ventilation, and natural

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ventilation control mode [14]. Appropriate siting of the building has much to do with its energy savings. The footprint is relatively narrow and long. Such a footprint allows natural light to illuminate key areas during daytime hours, thereby reducing the lighting load. Attention has also been paid to the design of the building envelope to maximize thermal performance as a best practice. This is carried out by taking local energy policy, urban planning and industry standards into account.

The design approach starts by reducing energy demands within the building envelope by minimizing losses and optimizing solar gains. The architectural rendering of the building is shown in Figure 1. Figure 2 shows the proposed design of midrise building while the proposed design of townhome building is shown in Figure 3.

When it comes to the building envelope under consideration, there are several parameters that were taken into consideration to reduce energy use. These include the layout of the community, construction and materials used and ventilation. The layout of the community plays a large role in the energy consumption. The building is designed to be built on a long and narrow piece of land which would increase levels of natural light during the day time and therefore decrease the need for electrical lighting. A long and narrow residential design, as shown in Figures 1 and 2, allows for cross ventilation. Large windows have been implemented into the design of both the townhome and midrise units which also increases the amount of natural light. The townhome unit, specifically, features a back-split rear for sunlight access into the basement.

Three different systems were evaluated using modeling tools such as EnergyPlus, Radiance and Window simulation [15]. These three systems include a micro-perforated screen, tubular shading structure and an expanded metal mesh. The results showed significant reduction in energy use. The micro-perforated and expanded metal mesh indicated reductions of 30-50%. The expanded mesh, however, performed the best and most consistently, resulting in energy savings that reached 47%. It should also be noted that within the study it was concluded that the south and west sides of the building were the most likely to impact energy savings when it came to window solar control [16]. The potential for energy savings within the proposed building using a similar window system would be extremely beneficial especially on the south and west sides.

3. Thermal Modeling

Thermal modeling in this study was performed for both HVAC system as well as energy-efficient construction materials.

3.1 HVAC Energy Efficiency

Nearly every energy model requires the user to select a HVAC system. The heating and cooling demand is generally driven by the goal of maintaining the occupied space within a comfortable temperature and humidity range. The most widely promoted guidance for thermal comfort comes from the American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) in the form of the ASHRAE 55 standard for thermal environmental conditions for human occupancy (ANSI/ASHRAE 2010) [17].

Among building energy services, HVAC system is the most energy consuming segment, accounting for about 10–20% of final energy use in developed countries [18]. The HVAC system generally contains a source of heating and cooling, a distribution system, and a technique for supplying fresh air. These include boilers, furnaces, and electric resistance heaters which are typically used to add heat to buildings while cooling is typically accomplished via air conditioning units, heat pumps, or cooling towers.

It is expected that at least 5-15% energy waste due to unoccupied spaces being conditioned. Our goal in this study is to minimize this waste by retrofitting HVAC systems to enable room-level zoning where each zone is conditioned individually based on its occupancy. This will allow only occupied rooms to be conditioned while saving the energy used to condition un-occupied rooms. Previous studies have shown that by implementing a multi-zone system energy savings up to 30.4% can be achieved during the summer. However, zoning systems are expensive, and are, therefore, typically only used for very course-grained zoning of the building. Such technique is both spatially and temporally course grained allowing large areas of a building, to be zoned separately and scheduled with a low frequency.

In this study, SolidWorks was used to simulate a multi-zone HVAC system for both the townhome units as well as the midrise units of the building as shown in Figures 4 and 5. Each of these zones would have its own thermostat and temperature would be controlled independently of the other rooms/zones.

Figure 4 and 5 demonstrates the results when one zone is activated. The air is able to circulate throughout the main living spaces (kitchen, living room, dining room, etc.) which will primarily be used during the daytime. As the bedrooms are not typically used during the daytime, their respective zones can stay turned off and energy is conserved. Overall, it can be seen that by dividing the unit into three zones occupant comfort can be increased by individual temperature control. Also, energy is conserved by reducing unneeded air supply to areas that are not occupied at various times of the day and night. In addition, energy savings would be increased if more zones were implemented. Also, by allowing each occupant to adjust the room temperature individually allows for maximal comfort.

3.2 Construction Materials

Thermal modeling was also performed using BEopt 2.3.0.2 along with the EnergyPlus simulation. Various materials were selected for the building, windows, roof as well as specifications of the HVAC system. The energy savings by incorporating a solar water heater was investigated as well. Materials with a high R-value were selected as a higher R-value means less energy loss. Wood studs, concrete masonry unit (CMU), structural insulated panels (SIP), insulating concrete forms (ICF) were selected. The U factor was taken into consideration and materials for the window systems were selected based on this (lower U value corresponds to better

insulation). Appliances such as the refrigerator, stove, washer, and dryer were selected to be the most energy efficient.

Figure 6 demonstrates the difference in the results from the midrise building when a solar water heater is used and not present. The water is heated by the means of an electric tankless water heater with an energy factor of 0.99. The total electricity use is 12377 kWh/year (Figure 6a). Since the model used for the computation was one fifth of the size of the proposed building, the energy use would be 61885 kWh/year for the proposed building within the case study.

The results of incorporating a 64 sqft closed loop solar water heater as well as the use of the electric tankless water heater are shown in Figure 6b. The total electricity use is 10633k Wh/year for the model and 53165k Wh/year for the proposed building. When comparing the results an energy saving of approximately 14.1% is achieved by implementing the solar water heater.

Similarly, the townhome was modeled as seen in Figure 7. A similar investigation was lead in regards to the electricity use with and without the solar heater. Figure 7 demonstrates the results without the solar water heater and with the use of the electric tankless water heater that was mentioned previously. The energy use for the model is 17978 kWh/yr. Since the model is scaled to one third of the proposed building, the energy use for the proposed building would be 53934kWh/yr. Figure 7 also shows the results when the 64sqft closed loop solar water heater is incorporated into the townhome. The energy use for the model is 16427 kWh/yr and 49281 kWh/yr for the proposed building. When comparing the results, an energy saving of approximately 8.9% can be achieved with the implementation of the solar water heater.

The possibility of incorporating a rooftop turbine ventilator was examined. From previous research [19], it was determined that as the size of the turbine diameter was increased so did the ventilation rate. It was also determined that increasing the turbine height by 15% could improve the air flow rate by 13.5%. Another important aspect was the fan blade shape where a curved shape produced a 25% larger air flow rate than a straight vane.

4. Efficient Lighting System

Lighting is the most pervasive element and of essential need in modern buildings. It is a significant component of the total energy consumption in a building, often comprising 20–30% of total building energy consumption. In addition to the advancements in light source-technologies, from incandescent and high intensity discharge (HID) to fluorescent and compact fluorescent (CFL) to light emitting diodes (LEDs), controlling the artificial light sources to provide illumination of the right kinds (adequate light levels, colour temperature and colour rendering), to the right places (offices, recreation areas, etc.) and at the right times provide significant opportunity for energy savings.

Modelling the lighting also allows the average solar light trespass throughout the days of the year to be taken into account, providing a basis for determining the average contributions from artificial light required to maintain consistent illumination in each space, making it possible to calculate the typical dimming levels for luminaires. Additionally, integrating the lighting control system with the HVAC controls through the Building Automation System (BAS) and with individual plug load controls can provide substantial energy savings and leads the way to the commercial realization of sustainable building [3].

For the building, the digital addressable lighting interface (DALI) reference design has been adopted. DALI is a concept that stands for an intelligent lighting management system that provides increased energy savings, easier installation and maintenance, and maximum control and retrofit flexibility in an entirely open standard. It is defined in IEC 60929 and has been updated in IEC 62386. One of the main reasons for this update is the inclusion of the LED device type. DALI is an affordable “open systems architecture” that allows any manufacturer’s devices to interface with any dimming, control, sensor, or fixture to create a room or area lighting system.

The use of DALI devices with wireless sensor network provides many parameters about the efficient lighting, this is very useful for saving energy and maintenance purposes, as it can detect any single lamp fault allowing a predictive maintenance and group replacement or schedule power consumptions rules enabling the integration of the lighting system in the building into smart MG approach, due to monitoring and acting capability.

Based on above, the projected energy saving for this building is about 80%. Lighting is selected based on energy efficiency, fixture lifespan and the degree to which the fixture’s composition could potentially harm the environment.

5. CCHP Microgrid

MG is the cornerstone and indispensable infrastructure of smart grid [18]. It is defined as a cluster of loads and energy generation sources operating as a single controllable system that provides both power and heat to its local area. Development of the CCHP MG by using various loads and renewable energy sources has drawn considerable research attention recently. Compared with conventional CCHP systems, the CCHP MG has novel and greater functionality, because the CCHP MG not only satisfies the cooling, heating and power demands of buildings, but also interacts with the main grid to provide reserve, peak-saving and demand response services, and provides improved capability for integration of renewable energy sources [20, 21].

The majority of electrical loads within a building can be grouped into lighting subsystems, computing equipment, individual plug-loads and HVAC related equipment. All these subsystems must be optimized to improve the energy efficiency of the building. A schematic of the MG model proposed for the building is shown in Figure 8. Through optimal operation control of the MG, this system will enable the building to maximize the gain of the renewable sources, to improve energy efficiency, to decrease the energy bill, and to reduce greenhouse gas emission.

A number of factors are considered to estimate the amount of solar energy available on a building. First is the area of roof that is available to install solar-PV array. Due to the placement of mechanical systems on the roof, the available area is often less than the actual roof area. One way to increase it is by

installing solar-PV array on the wall. Besides the amount of space available, other important factors include the amount of energy production available from the solar panels themselves. This depends on the efficiency of the panels and the amount of solar radiation exposure. For this project, solar-PV array is proposed on the flat roofs.

Energy storage is not only designed to conserve energy but to allow demand shifting where energy can be stored during lower demand times and used during peak demand periods. For the proposed building, sizing energy storage for prolonged intentional islanding is not required, and in order to minimize the energy storage requirement (due to financial constraints), intentional islanded operation is limited to a single day demonstration [22].

6. Electromagnetic Fields Environment

In our environment there are levels of EMFs of different frequencies. There are electric fields (EF), magnetic fields (MF) from power lines, and radiofrequency (RF) fields from wireless communication systems. The strongest fields are 60 Hz from the mains power lines, and 400 MHz – 5.5 GHz from cell phone systems and other wireless technologies. In addition, there are frequencies in KHz, which are the result of other applications. All these fields are not well regulated and people unknowingly live in environments that are known to be detrimental to their health.

Electrosensitivity, or sometimes called electro-hypersentivity is not medically recognized as real sensitivity, but is widely considered a result of a psychological nocebo effect. Therefore, reducing EMF levels in buildings make electrosensitive people comfortable in the building.

For the above reason, we developed a projection of magnetic field emission levels from the existing and planned power system. As a first step, magnetic fields around the proposed location of the building were measured. Second, an analysis included calculations for the planned bus ducts and major conduit runs as part of the system was conducted. The four measured zones are shown in Figure 9. It was determined that zone 1 had significantly higher readings compared to zones 2, 3, and 4. Readings in zone 1, which borders Beechwood Avenue, ranged from 11 mG to 22 mG. The projected magnetic field levels on this zone would be little bit higher than typical ambient or background magnetic field levels found in buildings, which generally range from 0.5 mG to 3 mG (based on protection guidelines such as Safety Code 6 of Canada). After assessing the area, it was determined that this high magnetic field level was due to the presence of power lines and transformers which border the zone. Projection of zones 2 and 3 which border St Charles Street and Barrette Street, respectively, shows that the magnetic field levels range from 1 mG to 2 mG. This low level can be attributed to the fact that there are no power lines or transformers which directly border the property on these streets.

For this building, a scheme to implement EMF mitigation measures during the design and construction of electrical and communication systems should be implemented. Much of the EMF mitigation plan will be in the form of low-cost engineering modifications. The first measure is to change the planned routing of a high-current bus duct that connects the utility transformer to the building distribution equipment and importantly to avoid ceiling area routes. As a second mitigation measure, a special field shielding scheme should be incorporated into the new power facility construction sequence, which may include the installation of special magnetic field shielding material below the large utility transformer and on portions of the walls and ceiling, plus in areas of the adjacent electrical distribution room, prior to the placement of switching equipment.

Measures to reduce magnetic field levels that may exist in a building construction or as a result of building refurbishment or expansion are more efficient and cost-effective if implemented as an integral part of the construction process. Although the total mitigation plan slightly increased the price of the utility upgrade, it was a fraction of the cost — not counting the tenant dislocations — that would have been required to correct the problem had the owner tried to mitigate the fields after construction.

Mitigation and shielding of existing EMFs are a reasonable way to create healthier environment in the building. To create such an environment, consideration should be given to use shielding techniques from the side that borders Beechwood Avenue, properly locating transformers, location of main electrical feeder lines into the building, and use of wired systems or proper placement of wireless routing communication systems.

7. Concluding Remarks

The objective of this work is to maximize energy efficiency, optimize occupant comfort by providing better EMF environment, reduce dependency on the grid by implementing sustainable strategies in designing a residential/office building. Creative solutions capitalize on energy efficient technologies; a CCHP MG with integrated control aspects; and mitigation techniques to create EMF healthier living environment. HVAC Zoning technique is proposed to reduce HVAC energy usage as well as incorporating solar water heater and energy saving building materials. The CCHP MG provides an effective solution to energy-related problems, including increasing energy demand, higher energy costs, energy supply security, and environmental concerns.

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The Impact Of Environmental Management System ISO 14001 Adoption on Firm Performance

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Abstract—This study employed event study methodology to examine the role of institutions, resources and dynamic capabilities in the relationship between the Environmental Management System ISO 14001 adoption and firm performance. Utilising financial data from 140 ISO 14001 certified firms and 320 non-certified firms, the results of the study suggested that the UK and Irish manufacturers were not implementing ISO 14001 solely to gain legitimacy. In contrast, the results demonstrated that firms were fully integrating the ISO 14001 standard within their operations as certified firms were able to improve both financial and operating performance when compared to non-certified firms. However, while there were significant and long lasting improvements for employee productivity, manufacturing cost efficiency, return on assets and sales turnover, the sample firms operating cycle and fixed asset efficiency displayed evidence of diminishing returns in the long-run, underlying the observation that no operating advantage based on incremental improvements can be everlasting. Hence, there is an argument for investing in dynamic capabilities which help renew and refresh the resource base and help the firm adapt to changing environments. Indeed, the results of the regression analysis suggest that dynamic capabilities for innovation acted as a moderator in the relationship between ISO 14001 certification and firm performance. This, in turn, will have a significant and symbiotic influence on sustainability practices within the participating organisations. The study not only provides new and original insights, but demonstrates pragmatically how firms can take advantage of environmental management systems as a moderator to significantly enhance firm performance. However, while it was shown that firm innovation aided both short term and long term ROA performance, adaptive market capabilities only aided firms in the short-term at the marketing strategy deployment stage. Finally, the results have important implications for firms operating in an economic recession as the results suggest that firms should scale back investment in R&D while operating in an economic downturn. Conversely, under normal trading conditions, consistent and long term investments in R&D was found to moderate the relationship between ISO 14001 certification and firm performance. Hence, the results of the study have important implications for academics and management alike.

Keywords—supply chain management, environmental management systems, quality management, sustainability, firm performance

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Theoretical Paradigms for Total Quality Environmental Management (TQEM)

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ABSTRACT
Quality management is dominated by rational paradigms for the measurement and management of quality, but these paradigms start to "break down", when faced with the inherent complexity of managing quality in intensely competitive changing environments. In this article, the various theoretical paradigms employed to manage quality are reviewed and the advantages and limitations of these paradigms are highlighted. A major implication of this review is that when faced with complexity, an ideological stance to any single strategy paradigm for total quality environmental management is ineffective. We suggest that as complexity increases and we envisage intensely competitive changing environments there will be a greater need to consider a multi-paradigm integrationist view of strategy for TQEM.
Keywords: total quality management (TQM); total quality environmental management (TQEM); Ideologies (philosophy); Theoretical paradigms.

Introduction

Quality management is dominated by rational paradigms for the measurement and management of quality. For example, quality is often measured by a rational functionalist approach that focuses on scientific reductionist study by dividing quality into constituent variables. This functionalist paradigm is inherent in the literature addressing the accreditation of quality and total quality environmental management. Competitive changing environments are becoming more dominant due to increasing competition in a more global information economy, and an increase in competitiveness promises to be a significant trend (Senge, 1990). To deal effectively with complexity, managers are required to balance many issues to provide comprehensive strategies. To effectively manage these issues requires an understanding of the advantages and limitations of various theoretical paradigms used for total quality environmental management. However, the practical implications of managing quality within specific paradigms, including the advantages and limitations of managing by these specific means, seem to be lacking within the literature. These advantages and limitations are discussed below to provide a more comprehensive view of strategies for the management of quality that is able to deal more effectively with complex situations. A review of these advantages and limitations suggests that

in complex situations, an ideological reliance on any single strategy paradigm to manage quality is ineffective.

The strategic demands of the management of quality

Quality is a complex phenomenon based on perception by individuals with different perspectives on the quality of products and services. These perceptions have been built up through the past experience of individuals and consumption in various contexts.

Consequently, quality encapsulates time and other contextual dimensions that add to the complexity of what is essentially a subjective evaluation of the quality of goods and/or services by the consumer. Strategies for managing quality, therefore, need to consider this inherent complexity and build complexity into quality management models. Any single paradigm provides a too narrow view to capture complexity, and the multi-faceted nature of reality (Burrell and Morgan, 1979). Therefore, to tackle the issue of complexity, a multi-paradigm approach to the management of quality is outlined here. Several writers have noted that much of the management literature addressing the topic of quality is highly evangelical and universally prescriptive. This is especially stated in relation to the total quality management (TQM) literature (Silvestro, 1998), with its roots in production of manufactured products. In contrast, the service quality literature is less universally prescriptive and benefits from more academically rigorous empirical research (Silvestro, 1998). Ideological views, however, are still present and dominant. For example, the rational functionalist view of strategy for the management of quality which suggests that service quality can be measured and managed through systematization (Levitt, 1972) is still influential. This view becomes ideological when implemented without any consideration of context, even when measurement is problematic and a more holistic view may be required. The core assumptions and beliefs underpinning this ideological view and the limitations of managing quality in this manner are given less prominence. We suggest that these limitations become much more pronounced as complexity increases.

Total quality management (TQM): definition and key principles

TQM is among the most prominent operations management approaches in the 20th century (Ahire and Ravichandran, 2001). From a taxonomy standpoint, TQM emerged in the 1980s but its roots go back to the scientific management principles of the 1920s (McAdam, 2000). Many writers have presented various definitions for TQM, as follows:

- TQM is an organization-wide philosophy that focuses on systemically and continuously improving the quality of products, and processes and services (Daghfous & Barkhi, 2009).
- Total quality management (TQM) is a set of management concepts and tools that aims to involve managers, employees and workers to yield continuous performance improvement (Powell, 1995).
- It is one of the most popular and durable modern management concepts and philosophies developed in the end of the last century, which has had a profound and unparalleled impact on modern business history (Prajogoa & Hongb, 2008).
- Good total quality management is the source of competitiveness (Markowski, Xu & Markowski, 2008).
- Total quality management is a management philosophy that fosters an organizational culture committed to customer satisfaction through continuous improvement (Kanji, 2002).

The key The key components of TQM are, hence, customer focus, continuous improvement in products processes and services, statistical measurement, benchmarking, as well as the employee empowerment (Daghfous & Barkhi, 2009). Thus, a body of organizations started to implement total quality management (TQM) in order to generate a competitive advantage (Chan & Quazi, 2002; Nilsson, Johnson, & Gustafsson, 2001), improve the organization's overall business process (Lau & Idris, 2001), generate improved products and services (Wads- worth, Stephens, & Godfrey, 2002), improve organizational effectiveness (Fok, Fok, & Hartman, 2001), productivity (Huang & Lin, 2002) and overall reputation(Saremi, Mousavi & Sanayei, 2009). In other words, Within the field of quality improvement, total quality management (TQM) is the most referred as well as most used criterion for enhancing organizational quality (Chen & Chen, 2009).

From a critical perspective, Ezzamel (1994) suggests that the theoretical promise of TQM is not necessarily matched with the experience of its implementation and outcomes. He further suggests that when implementing TQM there is a tendency for management to over-emphasize the use of detailed written rules and procedures, which separate the individuals from their work. Furthermore, TQM can be a source of discomfort and fear.

The most common fears identified by Morgan and Murgatroyd (1994) are, as follows: (a) a fear that the widespread adoption TQM will reduce the number of jobs available or the opportunities for promotion; (b) a fear that their own sphere of influence and control may be affected as empowerment develops; (c) a fear that the work they undertake will become more complex; (d) a fear that the risks of TQM will not be compensated for through the reward and recognition structure; (e) a fear of skill inadequacy; and (f) concerns about team work arising from either a feeling that this depersonalizes their work or a feeling that they are unable to accept shared responsibility for their own work and that of others.

Further, Williams *et al*. (1994) maintain that the managerial assumptions underlying the TQM approach under-estimate the structural conditions of success and failure of the organizations as they misrepresent the pattern of performance. In fact, TQM principles recommend employee involvement in all levels of management in the form of 'quality improvement circles' and continuous adjustments of organizational activities. Top management involvement, providing resources and appropriate training so that people are given the ability to act within guidelines to achieve a goal, is of crucial importance to a successful TQM organization. The people must respond to this empowerment by working within policy, understanding the impact of their actions upon the internal and external customer chains and thereby earn the privilege to be empowered. So the influence and adverse effects of any structural conditions may be reduced by top management active involvement and regular meetings of quality improvement circles. The success of these adaptations is judged on the basis of customer satisfaction (both internal and external customers).

Total Quality Environmental Management (TQEM)

The results of the literature review show that the move to adoption of environmental business practices and TQEM has been viewed from a perspective heavily influenced by either normative or legal considerations by Klassen (2000), and Curkovic (2003), with some evidence that TQEM can be motivated by the potential for competitive advantage and improved public relations by Khanna and Anton (2002). Epstein (1996) found that for most companies, compliance is seen as an adequate position to assume. With compliance, the firm does only what is necessary to meet the letter of the law. It is a reactive position that means environmental problems are corrected once they have been created. Many have claimed this is relatively ineffective because it does not attack the causal factors, merely the symptoms (Alm, 1992). It is also a potentially dangerous position given the retroactive and

dynamic nature of many laws. That is, what may be in compliance today may be considered out-of-compliance tomorrow. As a result, the firm may find itself always spending to bring itself into compliance with regulations that are continuously becoming more stringent.

Table I: Different views which explain TQEM core concepts

Anderson et al. (1994)	*Powell (1995)*	*Tummala y Tang (1996)*	*Sila and Ebrahimpour (2002)*
Customer satisfaction	Closer customer Relationship	Customer focus	Customer focus and satisfaction
Visionary leadership	Committed leadership	Leadership	Leadership and top management commitment
Continuous improvement	Adoption and communication of TQEM	Strategic quality planning	Continuous improvement and innovation
Process management	Process improvement	Continuous improvement	Process management
Internal cooperation	Zero-defects mentality Flexible manufacturing	Design quality, speed and prevention	Employee training
Learning Employee fulfillment	Increased training	People participation and partnership	Teamwork Employee involvement Everybody's Participation
External cooperation	Employee Empowerment Open organization	Fact-based management	Quality information and performance measurement
	Benchmarking		
	Closer supplier relationship Measurement		

The challenge of determining whether it is better for the firm to simply emphasize compliance or whether the firm wants to become recognized as an industrial leader in the development and application of TQEM based systems describes the first of many obstacles and paradoxes surrounding the TQEM literature.

In large part, the failure of management to become more environmentally responsible is really a reflection of its inability to address and resolve these paradoxes and problems. The following are some of the most important paradoxes and problems associated with the development and implementation of TQEM systems:

- Hanna et al. (2000) claim top management must be willing to accept and champion corporate-wide developments if TQEM is to become widespread. However, when dealing with TQEM, some research has shown there is a strong bias in favor of ignorance at the highest levels of the firm by ReVelle (2000).
- Findings from Palmer et al. (1995) show that in the short run, implementing TQEM often causes costs to rise. However, there is a real concern as to whether customers are willing to pay the added costs associated with having something that is environmentally friendly (Hanna and Newman, 1995).
- It has been argued by Sroufe (2003) that being environmentally responsible ultimately makes a company more efficient and more competitive. However, there are many reported cases of environmentally responsible investments which have resulted in negative returns by Klassen and Angell (1998).
- Melnyk et al. (2001) and Ahmed (2001) support the notion that ideally, the most appropriate place for considering TQEM issues is in the design phase since the amount of waste generated is a direct consequence of decisions made during design. However, Sroufe et al. (2000) claim there is a lack of appropriate measures and tools for capturing the environmental impact of designs.
- There is evidence by Revelle (2000) that managers need frameworks or guidelines which they can use to better understand what TQEM is and its components. However, a great deal of the information surrounding TQEM is either legally based or derived from anecdotal stories and case studies as pointed out by Curkovic (2003).
- Finally, and the focus of this study, managers have difficulty assessing the impact of TQEM programs because of the lack of appropriate measures. In order for TQEM to be given serious consideration by a firm, it has been suggested by Epstein (1996a) that a process is required for evaluating TQEM by appropriately including environmental costs and savings for each investment option. How- ever, there appears to be a lack of easy-to-use measures.

Theoretical paradigms for total quality environmental management

Theoretical strategies for the management of quality are no different from other strategies; in so much as they advance core assumptions and beliefs that largely go unquestioned due to their implicit nature. Questioning the appropriateness of theoretical strategies based on these core assumptions and beliefs is an important task for a critical analysis of the application of theory. Unless it is proposed that theories can be universally applied without question, which we do not, the contextual factors that deem that a theory may be effectively applied or not applied in a particular context should be investigated by research.

To aid this investigation we use an integrational framework, grouping 15 different strategy paradigms based on their implicit core assumptions and beliefs (see Combe, 1999). In developing his

framework, Combe (1999) has argued the theoretical case for integrating strategy paradigms into schools of thought at a philosophical level to aid empirical research. What is missing from this literature, however, are the practical implications of managing within specific paradigms, including the advantages and limitations of managing by these specific means. Additionally, the case for integrating the advantages of specific paradigms needs to be explored, especially in the context of dealing with complexity. These issues are the focus of this current article.

The 15 different theoretical strategy paradigms (Combe, 1999) are now outlined to distinguish between various strategies for managing quality and to highlight the core assumptions and beliefs associated with each. Rational paradigms, developmental paradigms, deterministic paradigms, probabilistic paradigms and chaos paradigms are all outlined. We suggest that a reliance on only one theoretical paradigm by its whole-sale acceptance by managers can lead to an uncritical ideology within an organization in relation to its strategy for the management of quality. An alternative argument is developed in this article: that the advantages of specific theoretical paradigms can be integrated in practice. We investigate the advantages and limitations of each so that these may be accepted and understood. We further suggest that managers should configure the advantages of different strategy paradigms to benefit the management of quality in their organizations, dependant on the contextual factors faced by the organization. The multi-paradigm view is further necessitated, we suggest, as complexity increases. The main features of these theoretical strategy paradigms and the advantages and limitation for managing quality are as follows.

Rational paradigms

These paradigms emphasize the human brain's capability to receive, organize and interpret information in an attempt to reduce and rationalize complexity to try to make sense of the environment. The main focus is on internal explanations by analysis of phenomena present in the environment, and to forecast these phenomena deliberately and proactively into the future. This type of approach to strategy can be found implicitly in many concepts, theories and perspectives. Four major paradigms are evident in the literature. These are:

(1) *The rational planning paradigm.* The rational planning paradigm emphasizes a hierarchically imposed, normative model of in-depth analysis, planning, implementation and control. This perspective has its roots in the writings of Fayol (1949) and is dominant in much of the strategic management literature, such as the writings Ansoff (1965). The rational planning paradigm may be appropriately applied to the management of quality in relatively complex and reasonably predictable environments (Fredrickson, 1985). There are limitations, however, of managing quality by hierarchically imposed planning procedures and imposed views of quality from above. Problems can occur due to the enforcement of too much control that might not be appropriate for some contexts. In developing strategies for the management of service quality, a single approach to quality whatever the contextual setting, can lead to a lack of empowerment and alienation of the workforce. This lack of empowerment, while seemingly appropriate to service settings that require mass standardization, may not be appropriate to other settings such as professional services (Bowen and Lawler, 1992).

Imposing a view of quality from above can be highly political, and a de-motivation of the workforce lower down in the organization may occur if workers have alternative views. For example, when Kentucky Fried Chicken (KFC) entered the Japanese market the local manager had full responsibility and empowerment to establish a KFC as a brand in this new environment. After establishing a strong position for KFC, the headoffice imposed a new view of quality and reduced the power of the local manager. The latter resulted in demotivation of the workforce and a change in the perception of quality (Bartlett and Goshal, 2000). Another limitation of the rational planning paradigm is that it is

focused mainly on predicting the future based on internal interpretations of the external environment, and these interpretations can be biased. Cognitive biases can be the result of culture (Hitt et al., 1997) and/or past experience (Ireland et al., 1987) and these biases can result in inaccurate predictions, especially during periods of unpredictable change. In these situations rational planning can become ineffective.

(2) *The modernist paradigm*. The characteristics of modernist thought in an organizational context, according to Alvesson and Deetz (1996), are the instrumentalization of people and nature by scientific thought. Thus there are three aspects of modernist thought that need to be considered in relation to the management of quality: people, nature and the possibility of instrumentalization or control. Critical theorists such as Knights and Willmott (1987) have implied that strategies can be introduced for reasons of control and domination of the workforce, and therefore strategies for the management of quality may not be implemented purely for "quality" improvements. However, in some organizations requiring a high degree of standardization, some control and dominance may be inevitable, but this control and dominance may break down in other contexts. For example, strategies for the management of quality dominated by the modernist paradigm are likely to break down in more complex relational service contexts, where empowerment of staff is required and standardization of service is of little value to customers. Another problem with the modernist view is that it is anthropocentric because it focuses on the utilitarian value of products for the benefit of human lives by controlling nature through scientific technologies (Firat and Shultz, 1997). Many products, however, are not purchased for their utilitarian value but for their symbolic value. Consequently, modernism's focus on the product and product attributes may be myopic, and this may have serious consequences for a company managing quality from this perspective.

Post-modernist theorists such as Alvesson and Deetz (1996) point out that modernism are based on a false premise of control, which is illusory. They also provide the most damning critique of modernist thought when they focus on the disastrous consequences for the environment and the alienation of the workforce when humans try to control nature and people for their own ends. An example of this is provided by the factory farming system, which has a reputation of providing cost advantages in production through control of inputs such as food and living space, but at a very high environmental and ethical cost. Farm workers are alienated from nature rather than working in tune with it, because the system requires a focus on the maximization of output through cutting out the inefficiencies of nature. This farming system has also a reputation for a lack of perceived quality of output, because of its focus on quantity rather than quality.

(3) *The functionalist paradigm*. Taylor's (1911) reductionist view of scientific study aimed at maximum specialization is prevalent in the functionalist paradigm. Weber (1947) promoted a similar rational specialist view within the bureaucratic organization by recognizing the growing need for experts with technical knowledge. The functionalist operational view is, according to Drummond (1995), also prevalent in accreditation of quality and the total quality management literature. Morgan (1986) also considers that Taylor's (1911) views can be still found today in the routinized operational focus of organizations such as McDonalds. Another example of functionalism can be found in large service organizations such as British Airways (BA) when they measure the quality of their service by breaking it down into many functional parts. As many as 350 aspects are measured at BA (Prokesch, 1995) in order to assess every aspect of the service in minute detail. The management of quality within this paradigm is supposed to be efficiently achieved through formal methods of auditing, such as through procedures advanced by the accreditation of quality. A contradiction arises, however, because one form of total quality management, for example, implies a de-bureaucratization of the workforce through empowerment, but this is overlaid by an array of procedures that, by definition, re-deploys

another layer of bureaucracy (Grint, 1997). Other approaches to the management of quality, such as services blueprinting (Shostack, 1984) and quality function deployment (Stauss, 1993) can also take a functionalist approach. The bureaucratization of the management of quality is unlikely to be sustainable as a source of competitive advantage in certain highly competitive environments. Functional bureaucratic systems would have difficulty in coping with continuous changes in quality due to innovation and complex relational exchanges. Functional approaches can also divert the attention of managers to what is minutely measurable, rather than focusing on an holistic overview which may be a more accurate representation of the customers' perception of the quality delivered by the organization.

(4) *The holistic paradigm*. Follett's (1924) views, much influenced by Gestalt psychology, form the roots of a holistic view of strategy, where the focus is on an overview of the organization together with the advantages of human co-operation over human conflict. Thus, the holistic paradigm can be identified in the network literature, which addresses the issues associated with reducing risk by co-operation and forming relationships with others. It is also present in the stakeholder literature, which addresses the issues associated with balancing many demands on the organization. The network literature is especially influential in relation to strategies for the management of quality, because manufacturing networks have been seen to increase quality especially in sectors such as the manufacture of motor vehicles. A visit to a Toyota motor manufacturing plant, for example, can indicate how close some networks can co-operate towards a common quality goal. The suppliers even relocate to be in close proximity to the manufacturer. The holistic paradigm also implies that quality is best achieved through co-operation rather than imposed by hierarchies. Management through this paradigm therefore suggests an emancipation of the workforce through empowerment of the individual. This type of management seems highly appropriate for service companies where the level of standardization is low and encounters interaction high. From this perspective the management of quality is best achieved through a philosophical overview rather than a functional approach. The main advantages of rational paradigms are that they address the issues of cognitive analysis and proactive management and choice within the firm, and rational accountability to other stakeholders. However, the organizational behavioral literature (e.g. Cyert and March, 1963; Simon, 1957) argues that these advantages are based on the false premise of perfect rationality that does not exist due to cognitive limitations (Miller, 1956). Another limitation is that some degree of stability within the internal and external environments is required for the analytical aspects of rationalism to be effective. The increasing demands of hyper-competition within a global information economy suggest that this stability may be lacking at present.

Developmental paradigms

These paradigms emphasize development through education and change both at an individual and organizational level. The emphasis is on the capacity of humans to learn from undertaking tasks such as production processes and planning of strategy, and to adapt by learning from past experience. The main focus is on the building of knowledge, resources and internal capabilities within the firm, whether this is done proactively or a consequence of other activity.

Three major paradigms are evident in the literature. These are:

(1) *The evolutionary (Lamarkian) paradigm*. This evolutionary perspective is focused at the organizational level of analysis rather than the individual decision maker, as it considers that adaptive evolution of organizations occurs through learning. Therefore, it is considered by some writers, such as Hannan and Freeman (1989), to be more applicable to organizational evolution than the alternative Darwinian Theory that emphasizes passive unchanging organisms being selected by the environment.

At the level of the individual decision maker, Lamarkian theory advances the hope that individuals can be leaders of evolution and adaptive change. The literature on leadership of the management of quality seems dominated by universal generalizations from "gurus" and prescriptions based on autobiographical accounts (Blois, 1992). Learning from the experiences of chief executives' autobiographical accounts may be useful, but regard must be taken of the contexts where certain styles of leadership may be appropriate.

(2) *The process (developmental) paradigm*. The process developmental perspective focuses on both organizational and individual learning. This learning is brought about by undertaking production processes that enable learning curve effects, or management processes such as planning. Thus the focus of this paradigm is on so-called 'learning by doing' (Arrow, 1962). The developmental aspects can be emphasized by also experiencing and reflecting on the learning experience. An example is provided by the introduction of a process of continuous improvement in the Volkswagen Group, under the leadership of Ferdinand Piech. While working in small groups, employees were given the task of identifying processes and areas that could be improved to increase quality. After setting priorities of opportunities and immediately implementing them, employees reflected on these actions and were asked to apply this approach independently and in a continuous way. The management of quality within the process developmental paradigm relies on continual improvement over the long term. Organizations can learn from encounters with customers; from complaints and the process of service recovery (Heskett et al., 1990). Virgin Atlantic Airways provides another example of the effective use of this type of process developmental strategy through their system of documentation, which allows them to turn complaints into service improvements and innovations (Denoyelle and Larreche, 2000). Organizations can also learn to be less bureaucratic in their approach to the management of quality, if bureaucratization is having a negative impact on the process of managing quality and perceptions of quality by customers.

(3) *The resource-based view*. The critique of traditional economics developed by Penrose (1959) is considered by many writers (e.g. Wernerfelt, 1984) to be the historical influence of the resource-based view. This critique considers that traditional economic theory gives no notion to an internal process of development leading to cumulative movements of growth in firms. Thus for Penrose (1959) the firm was seen as a collection of productive tangible and intangible resources that provide services to production processes. From a resource-based view, the focus of strategy for the management of quality should be on developing difficult to imitate resources. Consequently, from this perspective companies should differentiate through the use of difficult to imitate "quality" resources such as the quality of innovation, design and service, because these are by definition more difficult for competitors to copy. An example of the difficulties that can be experienced by competitors when faced with this type of resource-based strategy is demonstrated by the very well established vacuum clearer manufacturers when competing with Dyson, due to the latter's focus on innovative design backed up by patents.

The main advantages of these paradigms lie in their focus on issues associated with adaptive evolution of the firm in a way that holds up the hope that management and the workforce can influence adaptive change, growth and long-term survival. These paradigms also address the role of the individual in providing skills and knowledge that are useful to the firm, to the mobility of labor and to society at large. Difficulties arise, however, from the never-ending capacity to absorb more information, knowledge, capabilities and other resources. The window of opportunity can close before knowledge and capabilities are built up. Thus, there is a need to balance the conflicting demands of exploration for more knowledge and capabilities, and the exploitation of existing knowledge and capabilities (Levinthal and March, 1993). Another potential problem is that devotees of these paradigms can be

focused too much on internal developmental issues, and thus lose sight of changing customer needs externally.

Determinist paradigms

These paradigms consider that events are determined by preceding events; therefore freedom of choice is illusory. The application of determinism in strategic management suggests that management has a passive role and is largely unable to influence change and long-term survival. A more balanced view, however, might consider that although the external environment acts on internal company resources in a deterministic fashion, these resources have been built up through past experiences and learning by a non-Darwinian process. There are many deterministic ways of thinking implicit within the strategic management literature. For example, the concept of a life cycle and the notion that strategies should be linked to different stages in that life cycle, implies a form of determinism. One major deterministic paradigm has generated most debate, however, and is outlined here. The evolutionary (Darwinian) paradigm. Darwinian Theory suggests that the origin of adaptations lies in natural selection acting on hereditary variations that are in their origin non-adaptive (Maynard Smith, 1975). The natural environment is the adaptive force acting on many variations of organisms, only the organisms that fit with the environment survive. Therefore the external environment is the ultimate selecting force and the individual does not possess the capacity to adapt itself. In an organizational context, this view of evolution considers that environmental change, resource specificity and structural inertia (Hannan and Freeman, 1984) emphasize selection. This view is prevalent in the population ecology literature. From this perspective, strategy for the management of quality is of little value, because the external environment ultimately determines success of organizations. In the age of the computer, a quality mechanical typewriter is unlikely to be purchased. Therefore, from this perspective, strategies for the management of quality should not be considered in isolation, but integrated with corporate and business strategies to provide a wider picture. Furthermore, due to resource specificity and structural inertia even strategies at another hierarchical level may not be effective in response to change. The answer to these problems may be to try to maintain organizational flexibility (Evans, 1991), so that the company is responsive to changing environments. The main advantage from this perspective is that there is a comprehension of the influence of links between the external environment to the internal environment. The disadvantages are that it undermines the effectiveness of rational choice, learning and proactive development by management.

Probabilistic paradigms

These paradigms are based on the importance of the dynamic interactive nature of the business environment so that modification of strategy by interaction with other factors is emphasized. Externally these factors may be due to changing competitors' offerings and changing customer needs, whereas internally strategy is realized through interaction with cultural beliefs and political forces that may cause barriers to change. This interaction means that both strategies for the management of quality, and indeed, the concept of quality itself, both need to take account of interactive contingent effects.

Five major probabilistic paradigms are present in the literature:

(1) *The ecological paradigm*. The focus of the ecological paradigm is on the dynamic and interactive nature of competition for external resources. Much of the empirical research utilizing this paradigm in an organizational context focuses its activity at the population or industrial level (Ingram, 1996). This approach has been useful for its longitudinal evolutionary perspective to indicate variables influencing

founding and failure of organizations. Further work developing the implications of the concepts of competitive exclusion and niche width at the organizational level to aid strategic management could be a suggested way forward (Baum, 1996).

The management of quality within the ecological paradigm suggests that organizations should pursue a differentiation strategy from competitors to exploit a niche before a competitor fills it. To achieve this, companies may use the concept of positioning to identify a niche and to differentiate themselves from competitors. For example, Virgin Atlantic Airways differentiated itself successfully as a service provider with great customer value within the highly competitive airline industry by focusing on three differentiation aspects: innovative surprises; entertainment and fun; and service recovery (Denoyelle and Larreche, 2000). Owing to the contingent nature of strategy being based on the availability of niches left by competitors, the timing of entry of new products and services is also important from this ecological perspective.

(2) *The process (emergent) paradigm*. March and Simon (1958) and Lindblom (1959) were amongst the first to critique the purely rational approach to policy formulation by suggesting that it assumes "perfect" intellectual capacities; sources of information; and time and money. These factors are always limited to a greater and lesser degree. The complexity of the problem was for Lindblom (1959) the key factor in determining the limited usefulness of the rational approach. Lindblom's (1959) suggested response was an incremental view in which decision making is remedial, proceeding in small steps not too far from the status quo. This does not necessarily imply that decision making should be merely tactical, as this approach can be led by a rational strategy that is adaptive and incremental (Quinn, 1980). This perspective is also associated with the manager addressing multiple conflicting goals, and a political dimension to decision making with associated barriers to change (Wilson, 1992). From the process (emergent) perspective, management needs to consider two main issues concerning the implementation of strategies for the management of quality. The first is the political implications of changes in product/service quality, because this issue can be controversial and can lead to an alienation of staff. This alienation may be especially acute if, for example, an organization known for high quality deems it necessary to reduce quality and "go down
market". The second is the political implications of changes in management processes. For example, Carlzon (1987) raises the problem of devolving responsibility for quality to one group at SAS airlines, which consequently made another group feel threatened by the loss of authority. The process emergent paradigm considers that hierarchically-imposed plans for the management of quality are likely to be modified by interaction with political forces within organizations. Consequently, strategies emerge by this interaction. This emergent strategy may not necessarily be a problem for management, because a strategy may emerge and be implemented that takes account of contextual factors within organizations. More effective strategies for managing quality within the context of organizational reality may result.

(3) *Game theory*. According to Camerer (1991), game theory is the analysis of rational behavior in situations involving interdependence of outcomes. Implicit in game theory is the presence of some degree of rationality, adherence to rules of the game, some knowledge of the other players and convergence to equilibrium. Whilst some might question some of these implicit assumptions, game theory holds up the hope of behavioral prediction by modeling how others are likely to play the game. Probabilistic prediction of competitors' responses within a dynamic changing environment would inevitably be very welcomed by many strategic decision makers. From this perspective, managers of quality should advance "follow the leader" strategies to ensure equilibrium with their main competitors, and build a reputation for retaliation and holding grudges to ensure "mutually assured destruction" (MAD) (Whittington, 1993). For example, the retail chains SPAR and Billa (an Austrian

associate of the German REWE Group) continually monitor the pricing strategy of the other to ensure equilibrium. This is required because a change to the price of any part of the product assortment is a signal to consumers of the best value retailer.

(4) *The behavioral paradigm*. In achieving rational cognitive explanations for behavior, research has tended to minimize the effects of the settings in which the behavior occurs (Foxall, 1992). Thus the behavioral perspective has received less attention. This paradigm, also associated with the behaviorist writings of Skinner, attributes action to external factors to the individual such as reward and punishment stimuli in a probabilistic fashion. Thus the behavioral perspective is the antithesis of cognitivism (Foxall, 1992). The management of quality within the behavioral paradigm suggests an interactive trial and error strategy based on positive and negative feedback from consumers. Kentucky Fried Chicken's market entry strategy into Japan can be considered to be based on interactive trial and error, because most of the highly standardized products and processes had to be adapted towards the unique Japanese customer and environmental requirements. The main advantage of trial and error strategies are that the chosen strategy should be highly adapted to present customer needs. The main disadvantage is the cost of too many trials.

(5) *The social contextual paradigm*. Whittington (1993) argues strongly against considering strategy out of context because organizations are socially embedded and therefore strategies need to be studied in their social, economic and political context. This paradigm suggests that universal prescriptions for the management of quality are unlikely to be effective, because they lack the context that made them effective in a different culture. From this social embedded perspective it is no accident that Italian and French design and fashion companies are the leading providers of high quality luxury products, accessories and haut couture, and the Moe¨t Hennessy Louis Vuitton Group is the world leading manufacturer and supplier of 50 top luxury brands(Arnault and Wetlaufer, 2002). Another example of the social embeddedness of companies can be seen through the exploitation of the unique apprenticeship system in the German-speaking area, which allows them to differentiate on the manufactured quality of components, tools and machinery. The main advantage of probabilistic paradigms is that they recognize the issues of interaction and exclusion in a dynamic competitive environment. The recognition that a company is not isolated from the moves of its competitors, the behavior of consumers or its social context is important. These paradigms also incorporate environmental complexity and speed of reaction to customer needs and competitive moves, which are consistent with the relentless pressures on firms in competitive markets. While these paradigms highlight the dynamic interactive nature of competitive business, they can lack the analysis of rational paradigms and the long-term view of developmental paradigms. These could be considered to be the main disadvantages of probabilistic paradigms.

Chaos

These paradigms consider that management has to address complexity and unpredictability. An application in a management context can suggest that the consumer is unpredictable and fickle, therefore rational strategy is of little value. Whereas another paradigm emphasizes the inter-connectedness of phenomena so that a small change in one area can produce amplified chaos elsewhere. To overcome chaos organizations can focus internally on responses to unpredictability such as creative individualism, reactive speed and organizational ideology, rather than traditional ideology.

The post-modernist paradigm. This paradigm seems to emphasize the chaotic elements of business rather than directly applying chaos theory. Therefore, there is a focus in the post-modernist marketing literature on fragmentation of societies and global individualism. Consumers are considered to be unpredictable, often subscribing to multiple highly contradictory value systems and lifestyles (Firat et

al., 1993). Strategy in these circumstances could involve merging the customer and the producer. Therefore, writers, such as Firat and Shultz (1997), promote the trend towards customization to individual's self images, and the relationships and partnerships required to offer a customizing process, rather than a particular product. The management of quality within the post-modernist paradigm has to contend with these changes. From this perspective the features of products are less important than the images conveyed by them. Thus, customers purchase a pair of Nike training shoes, for example, not so much for their utilitarian value, but for their symbolic value (Crowther and Combe, 1999). Therefore from a post-modernist perspective, strategists need to re-consider the nature of quality. In an era of global hyper-competition symbolic quality seems to be more important than utilitarian product quality.

Chaos theory. According to writers such as Stacey (1995) business systems model chaotic systems based on non-linear amplifying feedback mechanisms that are extremely sensitive to initial conditions. At a critical point, equilibrium is punctuated by chaos. From this perspective managers need to recognize the inter-connectedness of organizational processes, so that there is an understanding that a decision taken to alter one process can cause amplified chaos elsewhere. However, as patterns of order are intertwined with disorder, it is possible to predict some aspects of the future over the short term. The implications for the management of quality are twofold. The first, is to recognize this inherent long-term unpredictability and to consider the systemic nature of organizational reality. This systemic nature suggests that managers should not expect control and should not separate the management of quality from other management issues, because they are all inter-connected. Senge (1990) provides a good example of these effects in his management game, which highlights the inter-connectedness and built-in delay inherent in a supply chain. A small increase in orders at the retail level encourages managers to over-order products from the wholesaler further up the supply chain so that demand cannot be met. Managers, it seems, do not anticipate the delay in supply that is built into the system and the inter-connectedness of their decisions to others also ordering from the same supplier.

The second, from a management perspective, is to focus on relatively stable aspects of the environment and the prediction and planning of strategy over the short-term only. The main advantages of chaos paradigms are that they recognize the issues of the inter-connectedness of organizational processes, together with the issues of unpredictable change that are especially pertinent as organizations contend with a move from national industrial economies to global information economies. The main difficulties lie in developing solutions to deal with different forms of chaos. As chaos theory predicts, change at the societal or organizational level is not continually chaotic, but can enter into more predictable periods. In these periods other paradigms may be more helpful. Table II lists the theoretical paradigms and summarizes the implications for TQEM.

Table II: Summary of the theoretical paradigms and their implications for TQEM.

theoretical paradigms	***Main messages for management***	***Advantages for TQEM***	***Limitations for TQEM***
Rational paradigms			
Rational planning	Address risk by analysis, prediction and planning for the future and be proactive	Effective in relatively complex (detail) and predictable conditions. Effective for simple products where standardization is required	Less effective for complex services (e.g. professional services) and unstable conditions. Hierarchically imposed strategies may not be accepted
Modernist	Control inputs to maximize outputs	Some control may be necessary for very standardized situations	Focused on quantity which can have a negative effect on quality
Functionalist	Break down complexity into its constituent parts	Useful for measurement of constituent parts of products/service quality	Management may be bogged down in the minutiae of what is measurable. Bureaucratic strategies may only be appropriate for very standardized situations
Holistic	The whole is greater that the sum of the parts, therefore, obtain a holistic overview. Develop networks to increase quality	A holistic overview is closer to the customers' view of quality. Management is not bogged down in minute detail. Networks have increased quality in practice (e.g. car manufacturing)	Lacks detail but this detail may be useful to highlight specific problems with part of the product/service quality
Developmental paradigms			
Evolutionary (Lamarkian)	Take a long-term perspective	Effective for building sustainable quality advantage	Can be too internally focused
Process learning	Develop quality by learning from processes	Incremental development is less risky than creative leaps	Can be too internally focused on small changes that are not important to customers
Resource-based view	Develop and exploit unique difficult to imitate quality resources. Competitive advantage is based on resource specificity	Difficult for competitors to imitate, e.g. quality of design/ innovation and co-ordination	Difficult to balance conflicting demands – exploit existing resources/ develop more resources

(Continued)

theoretical paradigms	*Main messages for management*	*Advantages for TQEM*	*Limitations for TQEM*
Deterministic paradigms			
Evolutionary (Darwinian)	Difficult/impossible to change due to structural inertia. Do not consider quality in isolation – quality myopia	Recognizes the need to consider external forces and resource specificity	Implications can lead to a passive fatalistic view of management
Probabilistic paradigms			
Ecological	Quality is a relative concept dependent on competition. Need to find a niche before competitors, therefore differentiate and focus on speed of response to change	Recognizes the business reality of a dynamic changing environment where quality also has to continually change	Can lead to cost disadvantages because differentiation is expensive
Process (emergent)	Strategy needs to address multiple conflicting goals and political issues. Expect modification to strategy. Different views of quality can be barriers to change	Effective explanation for political organizations with barriers to change. Strategy can take account of organizational context	Difficult to manage emergent issues
Game theory	Follow the quality leader to maintain equilibrium	Prospect of stable competition with main competitors	Focused on existing competition but other competitors can enter the "game" and change the rules
Behavioral	Difficult to predict successful products/services and level of quality, therefore use trial and error strategies using feedback from customers	Highly adapted to customer needs	Expensive because it requires a large number of options for customers to choose the favorites
Social contextual	Companies are socially embedded. Strategy should be studied within the social context	Socially embedded competitive advantage is likely to be sustainable	Socially embedded competitive advantage may not be unique enough
Chaos paradigms			
Post-modernist	Consumers are unpredictable, often subscribing to multiple contradictory value systems and lifestyles. Symbolic quality more important than utilitarian quality	Recognizes the importance of symbolic quality. Symbolic associations of the brand are difficult for competitors to copy	Brand building is expensive. Symbolic associations are difficult to study and measure
Chaos theory	The systemic nature of business systems suggests long-term unpredictability and the inter-connectedness of quality with other issues	Recognizes that quality is inter-connected with other management issues. Recognizes the delays and non-linearity of cause and effect	Dealing with systemic problems is difficult

Integrating the advantages of theoretical paradigms for TQEM

The previous discussion highlighted advantages and disadvantages of the various strategy paradigms that can be applied to the management of quality. It also suggests that in practice, organizations cannot rely on only one paradigm to effectively manage quality, because any one paradigm will possess limitations as well as advantages. These limitations need to be addressed from the perspective of alternative strategy paradigms. The advantages and limitations of strategy paradigms highlighted in this article suggest that the context is the important consideration when deciding which paradigms may be more appropriately applied to the management of quality. Thus important contextual issues such as the level of external environmental change, the nature of the organization, the nature of the market/s served, the nature of the industry, and the level of competition, will deem some strategy paradigms more appropriate than others. Consequently, managers need to integrate various configurations of strategy paradigms to benefit from their various advantages. We suggest that as complexity increases there will be a greater need to consider a multi-paradigm integrationist view of strategy for the management of quality.

Complexity is inherent in the management of quality in some contexts, such as managing relational services in intensely competitive changing environments. We therefore suggest that a multi-paradigm approach would be especially useful in dealing with the management of quality in these circumstances. If a manager has to address a multitude of problems, changing the mind-set from one single strategy paradigm to another single paradigm is unlikely to be an effective solution.

Conclusion

It has been suggested in this article that strategy paradigms should not be applied uncritically to the management of quality. The various theoretical paradigms employed to manage quality were discussed and the advantages and limitations of these paradigms for managing quality were highlighted. Many writers have advanced alternative strategy paradigms to deal with different forms of complexity. For example, Ansoff (1965) has advanced the rational planning paradigm and Shostack (1987) has suggested the fuctionalist paradigm to deal largely with detail complexity. Other writers have suggested alternative strategy paradigms to deal with more dynamic type of complexity. But when we face with complexity, an ideological stance to any single strategy paradigm for total quality environmental management is ineffective. We suggest that as complexity increases and we envisage intensely competitive changing environments there will be a greater need to consider a multi-paradigm integrationist view of strategy for TQEM.

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Water Quality and Coastal Management Profile Assessment of Puerto Galera Bay, Philippines

Ma. Manna Farrel B. Pinto

***Abstract*—**As global industrialization progresses, the environment remains to be at risk of disturbances brought by developments of cities and communities. Impacts of flourishing industries such as tourism require rapid growth of establishments and may threaten ecosystems and natural resources. Puerto Galera as a biosphere reserve and declared as the Center of the World's Center of Marine Shorefish Biodiversity is on the brink of ecological deterioration as tourism further develops in its coastal areas. Apparently, attempts were initiated to establish a baseline for designation of protection in the economic and coastal marine zones of Puerto Galera but continuity of its implementation and coordination of concerned units remains deficient. Indications of eutrophication have been observed based on water quality analysis although parameter values still comply with the national standards for coastal waters. Water quality data, biodiversity and hydrodynamic information, gathered from studies, and local government units were analysed to assess the condition of the coast as well as acting policies implemented by the local authorities. Sources of contaminants were also located in its three main communities, and their shores wherein in recommendations for installing wastewater treatment facilities and further improvement of policies of waste discharge must be addressed. With a conceptual framework proposed in the study, a comprehensive data analysis and coordinated management are necessary to form an integrated coastal management for further protection and preservation of the sustainable coastal marine ecosystem of Puerto Galera.

***Keywords*—**Coastal Management, Environmental Management, Integrated Resource Management, Water Quality

I. INTRODUCTION

Puerto Galera is a coastal lagoon located in the north-western most municipality of the province of Oriental Mindoro, Luzon, Philippines. It is a natural harbor covering an area of 4.2 km^2 at the south western end of the Isla Verde Passage and about 130km south of the City of Manila. Puerto Galera was also declared by UNESCO as a protected area for biodiversity known as the Center of the World's Center of Marine Shorefish Diversity. Also, known as a vital feature of the Sulu-Sulawesi Seascape and a Man and Biosphere Reserve since 1997, Puerto Galera is also a known tourist zone since 1978. It features coastal shores with a lagoon home to different tropical marine flora and fauna and a grotesque view for tourists. It was a voted member of UNESCO supported Most Beautiful Bays of the World Club in 2005. [1]

With its rich natural resources and aesthetic beauty, Puerto Galera also faced environmental threats from anthropogenic activities and establishments being built within the area. It was also declared an ecologically endangered zone in 1978 due to disturbed habitats as communities flourished along the coastal lines. As for initial analysis, several factors are attributed to its deteriorating coastal water quality such as waste and water discharge, tourism activities and inadequate water management. Due to increasing population growth, advancement of the communities, and further booming of the tourism industry, environmental risks on the water quality and marine resources of the Puerto Galera coast are expected to persist and may aggravate detrimental effects to its ecological system.

Thus, this study will incorporate water quality and hydrodynamic data and further analysis on its current coastal water management with the main objective of recommending an improved integrated water quality management system for the protection of the marine resources and coastal water quality of Puerto Galera.

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II. DESCRIPTION OF STUDY AREA

A. Location and Regional Setting

Puerto Galera is one of the municipalities that comprise the province ofOriental Mindoro in the Mimaropa Region (Figure 2; Region IV-B). At, about 123kmsouth of Metro Manila, it is bound in the east by the municipality of San Teodoro; in the west by the municipality of Abra de Ilog; in the south by Santa Cruz; and in the north by the the infamous Verde Island Passage and of Isla Verde. It is politically subdivided into 13 barangays: Aniuan, Baclayan, Balatero, Dulangan, Palangan, Poblacion, Sabang, San Antonio, San Isidro (White Beach), Santo Nino, Sinandigan, Tabinay, and Villaflor. It is classified as a 1st class or partially urbanized municipality. As of 2010, its population as recorded to total 32,521, with a population density of130/km2 (a total area of 247.85km2). It is bounded by about 42 km of coastline, while its municipal waters cover an area of 126.90 km2.

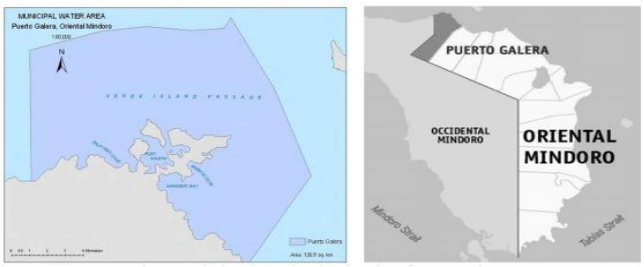

Figure 1. Location of Puerto Galera

B. Climate

Puerto Galera is characterised by a Corona Climate Classification of Type 1 i.e. it experiences two pronounced wet and dry seasons throughout the year. The months of June to October are characterized by a wet climate - bringing a high frequency of typhoons and hot and humid weather. On the other hand, the months of October to May

are described with relatively dry climate. November to February are the cool and dry months, while March to May are the hot and dry months. A graph of the daily averaged temperature and 24-hr precipitation values is illustrated in Figure 2. From there, plotted at about 167 mm/day is the average daily 24-hr precipitation reading of Puerto Galera, while at 27.1OC is the average ambient air temperature throughout the year. All of the data used in the analysis are from the US National Oceanic and Atmospheric Administration database.

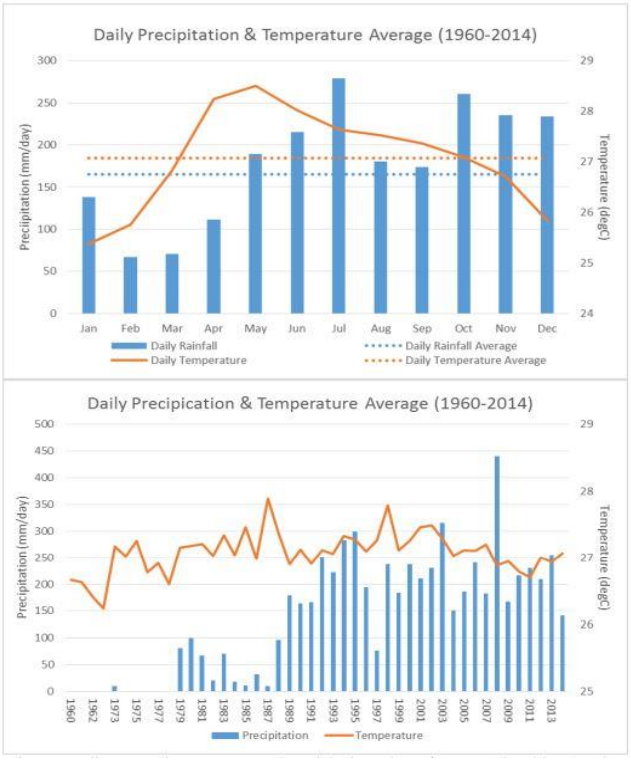

Fig. 2. Daily average temperature and precipitation values of Puerto Galera

C. Geography and Topography

Puerto Galera is located at the northeastern part of the island of Mindoro (Figure 3). The area is composed of a metamorphic complex - amphibolites,metagabbro, gneisses, greenschists, phyllites, slates, and marble [2]. Dated zircon grains of detrital and igneous origin revealed an age of 250 – 270 Ma (Mid toLate Permian), making it a part of the Palawan Continental Terrane that rifted away from the southeastern edge of Eurasia about 30 Ma [3].

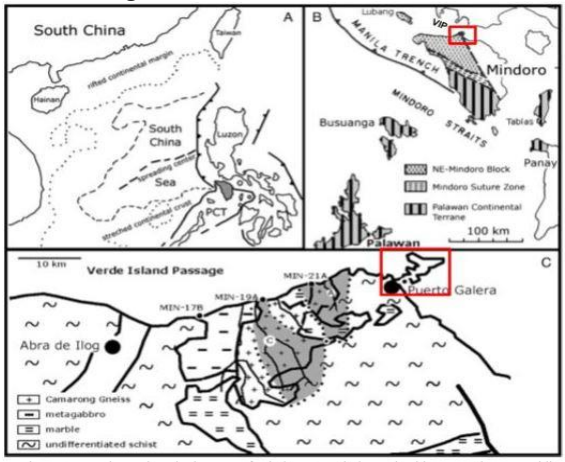

Figure 3. Location and geologic maps of Mindoro. Dotted line indicates 1000m isobaths and dashed line indicates 3000m isobaths.

D. Hydrology and Hydrography

For the purposes of the study, hydrological analyses through ArcGIS software and calculations were delimited to the coastal lagoon within the head of Puerto Galera, as this is the most endangered part of the lagoon. The boundaries of the catchments and stream networks within the coastal lagoon were delineated from an IFSAR digital elevation model (DEM) with a 10-m spatial resolution. Streams were identified from flow accumulation areas of about 10m in width Figure 4 presents the delineated watershed map of the Puerto Galera coastal lagoon. The total area of the watershed is calculated at 3.22 sqkm. Combining this with the lagoon's area, 3.63 sqkm, the total area of Puerto Galera's Catchment basin is 6.85 sqkm.

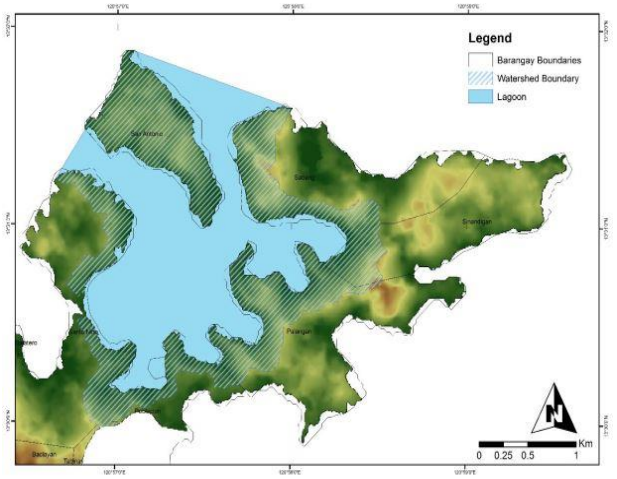

Fig. 4. Catchment map of Puerto Galera lagoon

Furthermore the total freshwater influx in the lagoon was calculated using the rational equation. First the land cover within the watershed was analysed and divided into four groups: low density residential areas (3.85% of total area; Figure 5), which consists mostly of small resorts and beach houses; medium density residential areas (2.98% of total area), which consists of small communities of residential houses, and several large resorts complexes; High density residential areas (1.55% of total area), which consists built-up areas or highly dense cluster of households; and lastly arable lands or forest covers (91.63% of total area). The total surface water runoff was calculated to be at 177,296 m3/day. Adding this to the fresh water precipitation over the lagoon itself, the total average fresh water influx is calculated to be at 783,765 m3/day. Because of the isolated nature of the coasted lagoon, the fresh water input from sub-surface outflow is disregarded.

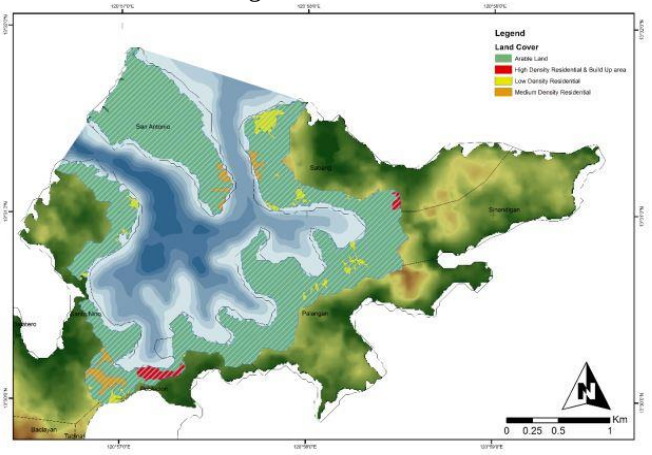

Fig. 5. Land cover map of Puerto Galera lagoon

Meanwhile, the total salt water influx of the lagoon was calculated at 2.90 million m3 per tidal cycle. The maximum tide level (spring tide) is reported at 1.6m while the lowest tide level (neap tide) is reported at 0.8m.

E. Hydrodynamics within the Coastal Lagoon

Meanwhile, the wind driven circulation patterns are simulated in the research of San Diego-McGlone et al., 1995. In their study, They modelled the currents generated by three different winds: (1) the northeast wind or Hanging Amihan, which normally occur during the dry months of November to May; (2) the southwest wind or Haninging Habagat, which normally occur during the rainy months of June October; and lastly (3) easterly winds which have no associated trade wind but is prevalent throughout the year at short intervals.[4]

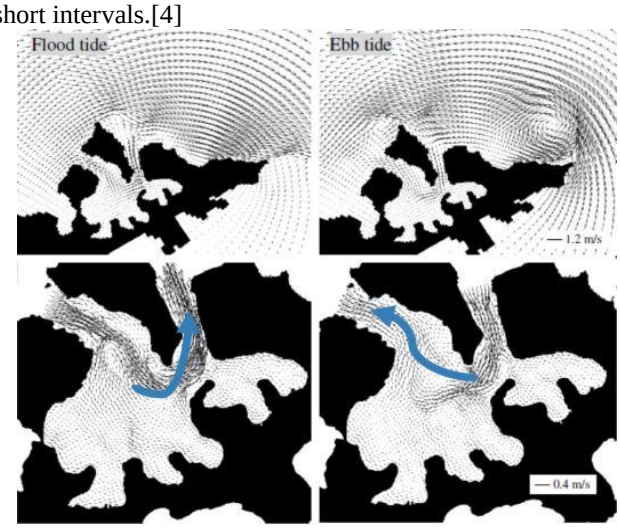

Fig. 6. Tide controlled circulations within the lagoon

They showed that during Hanging Amihan, a clock wise current occurs near the Muelle-Poblacion part of the cove. During Hanging Habagat, a strong counter-clockwise current is formed, and lastly, the easterly winds produce a weak clockwise current within the same area. It is important to note that the inner part of the cove near Sabang and Sinandigan remain unaffected by these trade winds.

Lastly, temperature driven currents are explored by in the study of Pokavanich et al. In their research, they were able to observe the intrusion of a cold-dense sea water from the Manila Channel. [5] This occurs ate several periods each day and are responsible for the dilution of the contaminants in the Muelle-Poblacion area. Again, the absence of this dilution effect is observed for the Sabang-Sinandingan section of the cove.

It is important to note that these circulation patterns are not exclusive to each other and their interactions must be further explored in order to fully understand their effects on the water quality. In spite of this, several general observations are made. The inner part of the lagoon is mostly stagnant and only weak wind-driven and temperature-driven circulations are present. The same may be said with the Sabang Sinandingan part of the cove, but the intensities of these currents are much weaker.

F. Biodiversity and Marine Resources

The biodiversity in the area is attributed to geologic events such as Pleistocene sea level lows, and island integration that took place with more intensity in the Philippine archipelago than anywhere else in the IMPA. Vicariance – the process by which gene flow is obstructed by geographical barriers and thereby leads allopatric speciation- had a high potential of occurrence within the area as more sea basins could form within the archipelago. [6] The coastal waters of Puerto Galera is also abound with seagrass meadows, mangrove forests, and coral reefs.

Seagrasses are flowering plants that are exclusively marine; the Philippines has the highest number of seagrass species worldwide, followed by Australia. They occur in shallow, near-shore areas.

Mangroves are trees that can tolerate high salinity levels and are found in intertidal zones. Both ecosystems serve as food and shelter for several marine organisms. They also help stabilize coasts by buffering the causes of coastal erosion. They can also serve as a clean-up mechanism for excess nutrients and contaminants. Perhaps, the most valuable environmental service of seagrass is its ability to sequester and store enormous amounts of carbon 'blue carbon" just like terrestrial ecosystems. Duarte in 1999 determined the C:N:P ratio of seagrasses at 474:24:1 by analyzing 27 species taken from 30 different locations. That is four times as much carbon as section organisms can hold. It has been estimated that the present rates of seagrass loss could lead to a release of 299 Tg carbon per year [7]. Seagrasses, therefore, are significant in combating the impacts of climate change.

Development in Puetro Galera towards a global tourism spot has put so much pressure on these ecosystems which can otherwise provide environmental services to the lagoon.

III. WATER QUALITY PARAMETERS

Aside from hydrographic and hydrodynamic data, the data from secondary and tertiary sources also primarily show water quality parameters that are important in characterizing coastal and marine water integrity. The studies from Pokavanich, Mcglone and Iizuka conducted sampling in 6-9 stations measuring values for Dissolved Oxygen, Turbidity, Chlorophyll, Nutrients and Temperature. Most stations are located in the coastal cove within the coverage of the watershed of Puerto Galera. The sampling sites are shown below.

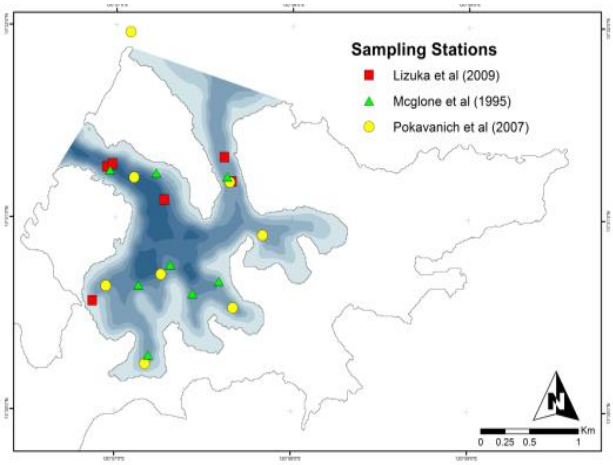

Fig. 7. Sampling stations in Puerto Galera [4][5][10]

A. Dissolved Oxygen

Dissolved Oxygen (DO) is the concentration of oxygen dissolved in water measured in milligrams of oxygen per litre of water (mg/L). It is the most important parameter that dictates the overall water quality of a body of water.

According to the US Environmental Protection Agency (2001), DO has an inverse relationship with temperature. It decreases as temperature rises and may affect biological and chemical activity of the water.

For Puerto Galera, the sample stations mainly at the Bay Interior, Northwest Channel and Outer Sea were able to collect the average DO data as shown below.

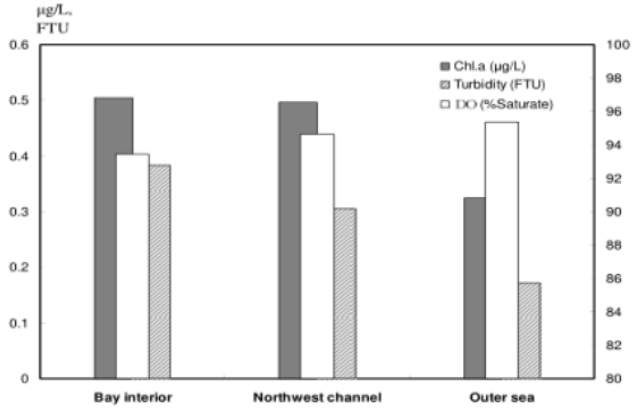

Fig. 8. Water Quality Data for Chlorophyll, Turbidity and DO [10]

As per water quality standards mandated by the Philippine Clean Water Act (RA 9275), the Puerto Galera coastal waters is classified under the SA, SB and SC types where it is regulated as a commercial and recreational water class. Puerto Galera also has marine and coastal reserves under the Marine Protection Area, aside from its commercial and tourism amenities. It is being monitored and protected by the designated bureaus (Department of Environment and Natural Resources, Environmental Management Bureau and the Puerto Galera Local Government Unit) for water quality management.

According to the said provisions, the coastal water quality standard value for DO should be at least 5 mg/L. With the calculated DO saturation at 94-96% and 6-7 mg/L of DO concentration, Puerto Galera still passes the standard water quality as it can still provide the needed DO for its biological and chemical processes. However, it can be noted that its lowest value falls under the bay interior in which where communities are located. Discharge of waste and run off may affect DO concentrations as organic matter from waste demands oxygen for decomposition. The presence of the phytoplankton biomass as well as blue green algae and diatoms affects the DO concentration that varies due to the amount of these organisms and nutrients influx in specific areas of the cove.

B. Turbidity

Turbidity is defined as an optical property that quantifies an estimation of the concentration of dissolved color and suspended solids in the water. It is measured in Formazine Turbidity Unit (FTU) where it quantifies amount of light penetrating a standard formazine solution in 180 degrees of incident light. A turbid water may sometimes indicate poor water quality due to suspended solids inhibiting photosynthetic activities of producers with low levels of DO.

Also, the parameter Total Suspended Solids (TSS) has a proportional correlation with turbidity. Hence, an increase TSS may increase turbidity values.

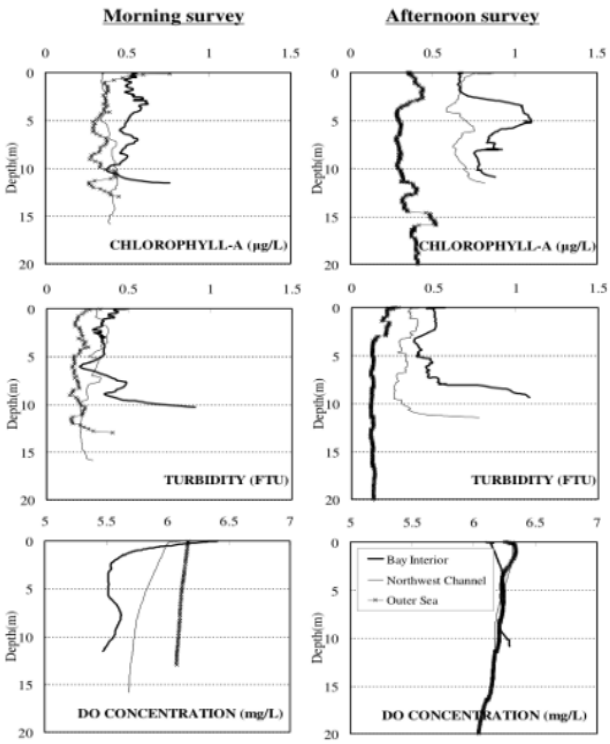

Fig. 9. Chlorophyll-a, DO and Turbidity values [10]

From the data in Figure 9, turbidity values for Puerto Galera range at 0.2-0.5 FTU which is relatively less turbid since 0.5-10 FTU is already passing value for potable water. This is also a positive indicator for good water quality.

Turbidity values are highest in the bay interior and northwest channel. This can be attributed to suspended solids and waste being discharged from the communities in the inner part of the cove. As for the northwest channel, as explained in its hydrodynamic circulation, this area is where most influx of seawater comes from. This may indicate active sedimentation coming into the cove and must be further mitigated to preserve shore loss.

C. Chlorophyll

Chlorophyll/ Chlorophyll-a is an indicator of the presence of nutrients although further test for specific nutrients can be made. It is the plant pigment that facilitates absorption of light and scattering energy which is vital for photosynthesis. Chlorophyll also indicates trophic quality of a body of water and can be measured in microgram of chlorophyll per litre (µg/L).

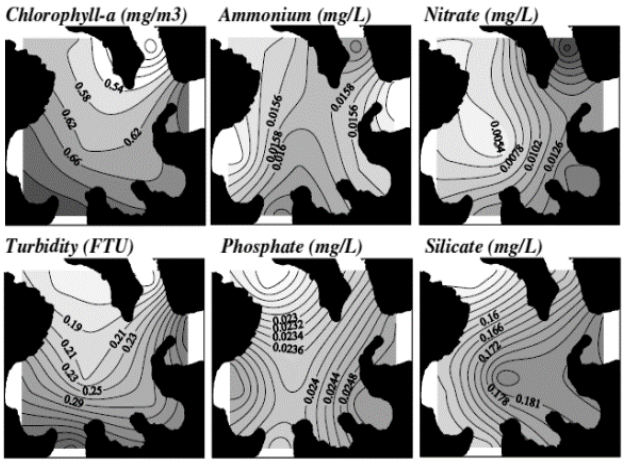

Fig. 10. Nutrient data for Puerto Galera [5]

As also shown in Figure 10, Chlorophyll-a values for Puerto Galera are at 0.3-0.5 µg/L indicating high amounts of producers which can attribute to presence of nutrients in the cove and indication of eutrophication. This can also influence DO concentration due to photosynthetic activity.

D.Nutrients

Nutrients are indicators of biologic productivity of a body of water. It is measured primarily by its phosphate and nitrogen concentration, as these nutrients affect the growth of all organisms. These are also nutrient pollutants with excess concentrations that can lead to eutrophication. Nitrate is usually released from industrial waste and fertilizer run-offs. It can also be found in sewage discharge. High values of nitrate changing to nitrite can be toxic to humans and aquatic animals. Phosphate, on the other hand, is common in nature but also widely used in fertilizers and detergents. Excessive amount of phosphate is also an environmental risk as it induces algal bloom. Other nutrients are also indicated with the presence of silicate, ammonium and nitrate compounds. Nutrients are commonly measured in milligrams per litre (mg/L)

From the figures above, nutrient data for Puerto Galera within the proximities of the cove at different distances and depths with ammonium, phosphate, silicate and nitrate concentrations. Previous studies proved Puerto Galera to be nitrogen limited with a Si:NO3:PO4 ratio at 7:2:1. Most significant values for nutrients come from the bay since waste discharge and run-offs are active in these areas. It shows that Puerto Galera is highly trophic and has presence of nutrients more than enough to sustain its biological productivity. Continual nutrient discharge and increase in phytoplankton population may eventually lead to hypoxia and water quality deterioration especially in the bay area.

E. Temperature

Temperature is also an important aspect in water quality determination as it affects all processes in the ecological system. A 3°C increase would be detrimental to all marine animals as it can affect the climate and CO_2 and oxygen assimilation of the sea from the atmosphere. According to the DENR standards for SC class for coastal and marine waters, there should not be an increase of 3°C based on a daily mean record for maximum temperature and also to avoid thermal pollution from commercial and industrial processes covered in the reported area.

Study and Sampling Date	Temperature °C
Fortes, Iizuka et al. (2009)	27-29 °C
Pokavanich (2007)	27-28 °C
Dela Cruz T. E. E. (2015), Dela Cruz A.(1976)	20°C 27-31 °C

Table I. Temperature Values for Puerto Galera [5][11][12][13]

Temperature data from previous studies are tabulated above. It should be noticed that Puerto Galera still maintains the same temperature range from 27-31°C despite the global warming and climate change issues. With regards to the DENR standards, it still complies with the 3°C increase limit but it should still be monitored for continuous compliance and protection of the coastal water and marine resources of Puerto Galera.

IV. MANAGEMENT POLICIES AND ISSUES

Under the Department of Environment and Natural Resources of the Philippines, it has tasked four units for coastal management- the Park and Wildlife Bureau (PAWB), the Ecosystems Research and Development Bureau (ERDB), the Environmental Management (EMB) and the Coastal Environmental Program (CEP). [14] These units are responsible for water quality monitoring, conducting research, implementing policies according to environmental laws and protecting wildlife.

Aside from the Clean Water Act along with directives for Ambient Water Classification and Effluent Standards, existing policies implemented in Puerto Galera are the PD 354 UNESCO's Man and the Biosphere Programme and enactment of Marine Protected Areas. [9] Other presidential proclamations included zonation of tourist and marine reserves under protection. Also, an initiative from the local government consisted of dumpsites but some were not established in good locations. Mining was also banned and marble mines were closed in 1995. [14]

However, despite comprehensive laws and even studies undertaken by scientists and the academe to establish a baseline for further research and protection, environmental threats still persist due to the rapid mode of development, lack of treatment facilities, weak enforcement of policies and monitoring. As Puerto Galera's communities are primarily tourism oriented with some agricultural exploits [15], establishments and resorts may continue to grow in an unregulated manner that may bring further sources of pollutants and too much nutrients, improper wastewater discharging and endangering natural habitat within the area.

Fig 11. Puerto Galera Tourist Spots and Community Map [18]

Among the three communities, the Muelle is the oldest and does not contain any sewage treatment system and its enclosed geography contributes to the areas carrying capacity of run off. Sabang area is mostly for high end tourist destination and despite its better location, lack of sewage system ends up its shoreline with development of eutrophication and algal bloom. White Beach, among the three, only has wastewater treatment facilities that helps in maintaining the water quality in the area. [16]

V. RECOMMENDATIONS

The resolution to the challenges addressed lies on a systematic framework that establishes a benchmark of the current conditions of the lagoon similar to the analysis presented on this paper. This is shown in Fig. 12 where

primary and secondary data on water quality, hydrodynamics, marine resources and even socio-economic considerations are put to analysis to develop an integrated coastal zone management.

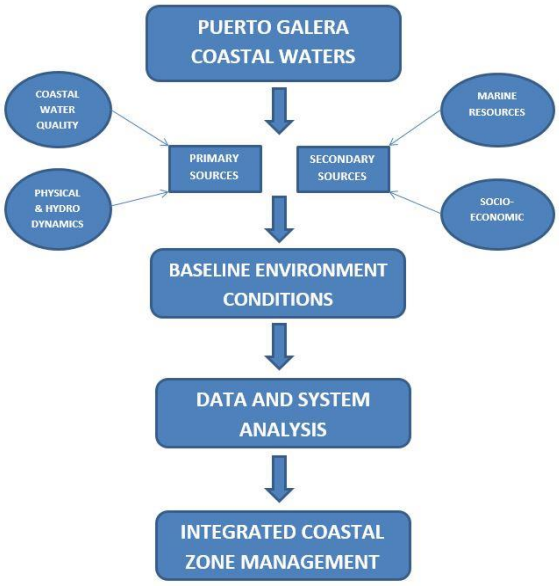

Fig. 12. Conceptual Framework for Puerto Galera Coastal Management

Currently, under Executive Order No. 533 – Integrated Coastal Management Policy, only 80 municipalities nationwide, where Puerto Galera is not included, are protected. [17] Thus, no integrated system holds its coastal management and independent government units implemented protection on only certain parts of the cove. Efforts had been initiated in the 1990's including that of the UNESCO proclamation and the Rio Conference, but still, continuity of such programs were not fully realized which calls for being tied up with the thrusts of an integrated coastal zone management.

Three main actions should be further undertaken to improve the Coastal Areas of Puerto Galera includes the following:

A. Construction of Sewage Treatment Facility/Wastewater Treatment covering Muelle and Poblacion.

Based on the study, the inner portion of the lagoon has higher concentration of pollutants contributing to the impending eutrophication of Puerto lagoon. With the assessed land coverage of developments in the area, a proposed plan is establishing a treatment system that catches discharges from hotels and resorts of the community.

Fig. 12. Coverage area for the proposed sewage treatment facility in Muelle, Puerto Galera (via ArcGIS software mapping)

B. Strict implementation and effective planning of zoning scheme for development and protection

Although average water quality values still comply with national standards for coastal waters, heavily concentrated areas with pollutants are experiencing deterioration. This is where reduction of waste must be focused on by implementing stricter rules and lessening discharge of effluents aside from treating in facilities. Stabilization projects must be conducted to avoid further siltation in natural barriers. Mangroves and seagrass natives of the area meadows can serve this purpose and may also serve dually as wetlands for further degradation of waste discharges. Regulating tourist and industrial development should also be part of an effective zonation of coastal areas, aside from the marine protected areas declared. Surveys and updated monitoring must be established on a regular basis to further protect and mitigate effects of municipal effluents.

C. Involvement of stakeholders in decision-making, monitoring and implementation of Coastal Management Resource Program

Coastal Resource Management is not the sole responsibility of the government but includes everyone. Aside from the proposed satellite wastewater treatment facilities in the communities, a bottom-up model encouraging from barangay-level communities to form clusters as managers of their respective coastal areas will enhance awareness and cooperation among the citizens. This will also strengthen local level decision-making jurisdiction of the government in Puerto Galera in their resource management.

VI. CONCLUSIONS

Data collated for Puerto Galera still fall within the standard water quality parameters presented by the Republic Act 9275 (Clean Water Act). However, it is also important to remember that with constant threats such as the uncontrolled development of communities due to unprecedented growth of tourism, improper waste disposal, lack of sewage treatment facilities, and the lack of a proper management and monitoring scheme, the degradation of the lagoon and its ecosystem is sure to occur.

Since Puerto Galera's tourism is geared towards biodiversity and the beauty of its diving spots, the proposed water quality monitoring programs implemented are geared towards it. The growth of tourist areas should be controlled and the proper zoning and easement of these establishments should be observed. Furthermore, the development of waste water treatment systems and the preservation, rehabilitation and promotion of natural coastal ecosystems such as mangrove forests and seagrass meadows will minimize the anthropogenic input of wastes into the lagoon. Thus, an integrated coastal management is necessary to implement these projects geared towards a sustainable coastal marine ecosystem in Puerto Galera Bay.

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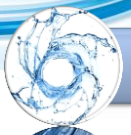
附錄二、電子海報資料

The Review and Contribution of Taiwan Government Policies on Environmental Impact Assessment to Water Recycling

Reporter: Yi-ching Tu

Bureau of Environmental Inspection,
Environmental Protection Administration, Taiwan
Oct 9, 2017

Outline


Introduction


Methodologies


Major findings


Conclusions

Introduction

The water resources issue of Taiwan is needed people who lives here to face squarely

3

Introduction

EIA Review

Request development organization to treasure water resources and execute water recycling

EIA Promise

ex Process water recycling rate 85%
Whole factory water recycling rate 75%

EIA Inspect

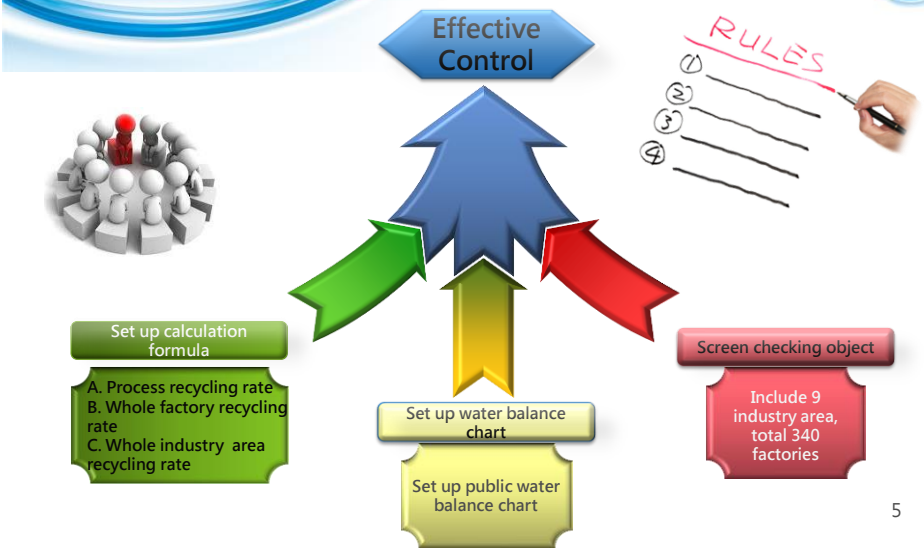
Inspect according to promise content

But…

If promise is just a value with no calculation formula, how to identify?

4

Methodologies



5

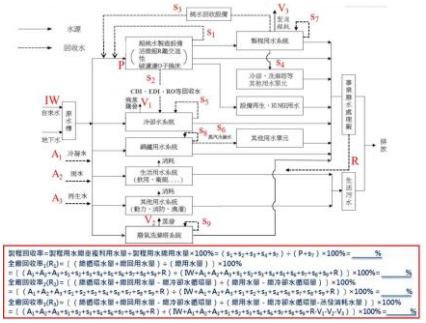
Methodologies-Environmental promise

9 industry area

Checking object	Environmental promise	
	Process water recycling rate	Total water recycling rate
Taoyuan Technology Industrial Park	–	70%
Longtan Aspire Park	85%	–
Taichung Precision Machinery Innovation Technology Park	–	70%
Yunlin Technology-based Industrial Park (area Zhuweizi)	–	70% (When developed up to 1/3 area)
Yunlin Offhore Industrial Park	–	75%
Liouying Technology and Environment Industrial Park	–	70%
Tree Valley Park	–	82.04%
Yongkang Technology Industrial Park	–	65%
CPC Corporation Petrochemical Business Div. CPC Naphtha Cracking Plant 3 expansion	95.84%	98.09% (Not included cooling tower)78.61%

Methodologies

Negotiate and Confirm
Public Water Balance Chart
and Set up Formula



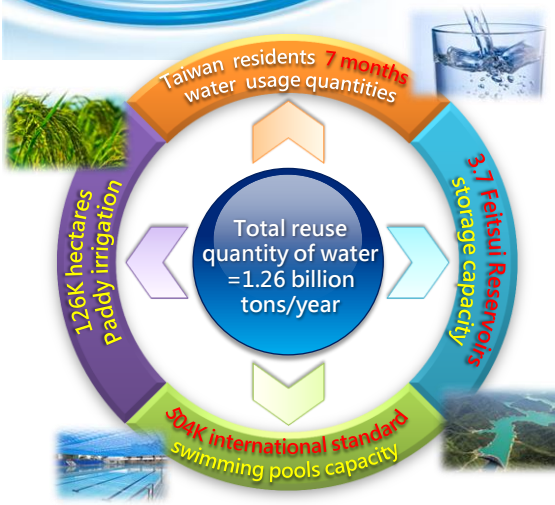
Expert meeting,
Discussion between Industry-Government-University、Seminar before Check

7

Methodologies

8

Major findings



9 industrial area Total reuse quantity of water

- One international standard Swimming pools =2,500 tons water
- Every hectare paddy needs 10K tons water for irrigation
- Every person needs 250 liters water per day
- Storage capacity of Feitsui Reservoir is 335 million tons water

9

Major findings

Original Water Intake Analysis

EIA highly valuing industrial area
Area：4,016 hectares
Water intake：125million tons/year

2015 Taiwan industrial area
Area：25,741 hectares
Water intake：1,601 billion tons/year

Annual area usage：31,060 tons/ha/year

Annual area usage：62,196 tons/ha/year

Because of EIA promise reduce half water intake, lessen environmental impact

10

Conclusions

Reuse
Recycle

EIA,
Gatekeeper of Water Resources Utilization and recycling

- Promise of EIA
- Environmental Protection & Sustainable Management of Water Resources

Water

Waste Water

11

THANK YOU FOR YOUR ATTENTION

Bureau of Environmental Inspection,
Environmental Protection Administration, Taiwan

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