

THE APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS IN ENVIRONMENTAL IMPACT ASSESSMENT IN AFRICA: CHALLENGES AND OPPORTUNITIES

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SUMMARY

Environmental Impact Assessment (EIA) involves collection of data used to predict the potential impacts of proposed activities. The environmental problems vary both in space and in time, hence cannot be tackled without consideration of the spatial and temporal contexts. The capacity to map, monitor and model the spatial component of the environmental problems offered by the Geographic Information Systems (GIS) can successfully be used in conducting the EIA. This paper discusses the challenges and opportunities of the use of GIS in EIA in Africa, zooming in on Tanzania.

INTRODUCTION

Environmental Impact Assessment (EIA) can generally be defined as a formal study process used to determine the environmental consequences of a proposed development project.⁽⁶⁾ The Geographic Information System Systems (GIS) offer a special environment to deal with the spatial properties of a project.⁽⁸⁾ GIS can be applied in all EIA stages: from the generation, storage and display of the thematic information relative to the vulnerability of the affected resources, to impact prediction and quantification, evaluation and finally, presentation.⁽⁵⁾

There have been initiatives of linking GIS to Regional EIAs in different locations such as industrial EIAs in India, Transportation EIAs in Malaysia and Water Resources and Thermal Power EIAs in Thailand. Several applications of GIS integration to EIA are also reported in the UK.⁽⁷⁾ GIS is found to be a very effective tool for conducting EIA studies and it can be used for various environmental applications.⁽²⁾

The adoption, adaptation and applications of GIS together with Remote Sensing (RS) and Geographic Positioning Systems (GPS) in other continents have not only shown that they provide better and timely resource and environmental information, their combined analytical and integrative power has also been found to provide the greatest opportunity to stimulate and understand the spatial and temporal dynamics of the real world in a comprehensive manner.⁽¹⁰⁾

APPLICATION OF GIS IN EIA

GIS have emerged as very powerful technologies because they allow integration of data and methods in ways that support traditional forms of geographical analysis, such as map overlay analysis as well as new types of analysis and modelling that are beyond the capability of manual methods⁽⁴⁾

A study on the role of GIS in improving environmental

assessment effectiveness revealed that GIS was used for a wider range of EIA applications as anticipated by the researchers (Joao & Fonseca (1997), in Looijen (1997)).

In order to determine how EIA practitioners use GIS, a questionnaire was sent to 98 environmental consultants in the United Kingdom and Portugal. In the questionnaire each practitioner was asked to fill what type of GIS operation was used for which particular EIA stage. The EIA stages included: screening and scoping, description of the project, description of baseline conditions, impact identification, prediction of impact magnitude, assessment of impact magnitude, impact mitigation and control, public consultation and participation, and monitoring and auditing.

Preliminary results of that study – based on 36 recipients – showed the use GIS in different EIA stages:

- *Screening and scoping:* data gathering, spatial modelling, impact assessment and calculation of impact magnitude.
- *Project description:* geographical context of the project.
- *Baseline conditions description:* documentation of environmental aspects and attributes, including biophysical inventories.
- *Impact Identification:* overlay analysis, e.g. the distribution of pollutants with resource maps or the integration of air quality modelling and habitat suitability analysis.
- *Impact magnitude prediction:* quantitative assessment of the percentage of a resource (conservation area) affected by a pollution or the creation of impact magnitude maps derived from the integration of the result of risk and air quality modelling with other data layers, e.g. soil susceptibility to acidification.
- *Impact significance:* spatial distribution of the impact and the variation between the different project alternatives, including the zero alternative.
- *Mitigation & control:* model and map distribution of pollutants. The result can be used to concentrate

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measures in the most affected areas. In addition, the geographical location and extent of mitigation activities can be shown with time.

- *Public consultation & participation:* preparing presentation material, explain the project to the public and allow a quick response to necessary changes.
- *Monitoring and auditing:* preparing design of monitoring programs, processing and storage of monitoring data (including data from remote sensing), comparison of actual outcomes with predicted outcomes, and data presentation, e.g. showing the variation of the location of pollutants with time.

The only exception to the use of GIS in EIA was in public participation. GIS was only used to communicate the results to the public and no attempt was being made to collect and integrate the public's view in the EIA process using GIS. Though GIS has the capability, practitioners did not use it for this purpose.

The mentioned disadvantages of using GIS for EIA were mainly the time and cost spent.⁽⁵⁾

CHALLENGES AND OPPORTUNITIES

There is potential for the use of GIS in the management of environmental resources in Africa.⁽¹¹⁾ though the adoption of and growth of GIS applications is hampered by the lack of adequately trained users and inhospitable organisational and financial environment.⁽¹³⁾

Before the late 1980s, measures to protect against environmental and social impacts were widely seen as delays to development or "luxuries".⁽¹⁾ Hitherto EIA is still a new concept in Tanzania, faced with:

- Lack of environmental database, hence much time is spent in collecting baseline data.
- Professionals in EIA are still few.
- Many decision-makers do not know its usefulness.
- In many cases, the EIA reports are used to complete requirements of international lending institutions.
- Assessment Methodologies usually lack scientific basis due to inaccessibility to modern tools.⁽⁶⁾

EIA has had very little impact on decision-making in Tanzania. In most cases, EIAs were extremely late in starting, under-resourced and generally omitted to involve other stakeholders to any meaningful extent. Most focused on outputs and paid little attention to process. Compliance with the recommendations of EIA has been the exception rather than the rule. Consideration of alternative project options was often absent, or extremely weak, and there were no examples where EIA had seriously considered cumulative impacts.⁽¹⁴⁾ In this case, GIS could be used as a tool in EIA methodology and decision-support together with its presentation appeal exploited to impart awareness to the decision makers.

There have been various initiatives to meet the challenges in Africa. For instance, in early 1990 the World Bank in conjunction with other donors and international agencies established The Program on Environment Information Systems (EIS) in Sub-Saharan to support the process of sustainable development in sub-Saharan Africa. The Program supports African countries as they assess their priority needs in terms of environment and land information systems, and analyse the technical, institutional, legal and economic issues hampering their possibilities of meeting these needs. It assists them in finding adequate, sustainable and long-term solutions to deal with these issues.⁽³⁾

From distant past, Africa had had a myriad of social problems. Ethnic violence, inter- and intra-state conflicts, and other threats to peace and stability in Africa have further escalated since the beginning of the 1990s. Already, beleaguered as the African region is, its landscape is deteriorating further in more subtle and dangerous ways. Environmental degradation and abuse -- as manifested mainly in accelerated desertification, soil depletion, land degradation, destruction of tropical forests and water pollution -- is raising serious concerns about the manner in which the continent's resource base is being exploited and managed, and about the long-term sustainability of that resource-base.⁽¹²⁾ The use of IT systems is imperative for African countries in their effort to industrialise and increase the standard of living of their people.⁽¹⁴⁾

The EIS and similar programmes offer the opportunity to see light in the end of the tunnel.

DISCUSSION

The application GIS in EIA in Africa is not luxury. It can be used as a tool in EIA methodology and decision-support, together with its presentation appeal exploited to impart awareness to the decision-makers on issues of environment and development.

The application, though technically feasible and useful, will be rendered meaningless if the EIA itself is taken as a mere formality, and the concerned parties do not adhere to it.

Good plans, policies, strategies and actions in conjunction with support like the EIS and other Institutional-Strengthening Programs, can change the situation.

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REFERENCES

1. Barrow, Christopher J. River Basin Development Planning and Management: A Critical Review. *World Development* Vol. 26. No. 1, pp. 171 - 186, 1998.
2. Devi, Sheila, Venkatachalama, P. and C. Natarajan. Geographical Information Systems for Environmental

- Impact Assessment (EIS) – A Case Study. *International Journal of Environmental Studies*, 1993 Vol. 43 pp. 115-122.
3. EIS-SSA. About the Program on Environment Information Systems in Sub-Saharan Africa. <http://www.grida.no/eis-ssa/about/about.htm> accessed September 28, 1999.
 4. Foote, Kenneth E and Lynch, Margaret. Geographic Information Systems as an Integrating Technology: Context, Concepts, and Definitions. <http://www.utexas.edu/depts/grg/gcraft/notes/intro/intro.html> Accessed 29/09/1999.
 5. Looijen, J.M. Environmental Impact Assessment. Unpublished Lecture Notes. International Institute for Aerospace Survey and Earth Sciences (ITC). 1997
 6. Mato, R. R. A. M. Environmental Implications Involving the Establishment of -Sanitary Landfills in Five Municipalities in Tanzania: the Case of Tanga Municipality. *Resources, Conservation and Recycling* 25 (1999) 1 – 16.
 7. Modak, Prasad Madhav EIA and GIS. <http://www.cedar.univie.ac.at/archives/eia/msg00227.html>. 09April, 1997. Accessed September 30, 1999.
 8. Mordehay Hacklay. The Use of GIS for the Scoping of Issues in Environmental Impact Assessment. Research description. <http://shum.huji.ac.il/~bonnun/mucky/abstract.htm>. Accessed in July 22, 1999.
 9. Mwalyosi, Raphael and Hughes, Ross. *The performance of EIA in Tanzania: an assessment*. IRA Research Paper No. 41; and IIED Environmental Planning Issues No. 14. 1998.
 10. Odenyi, Peter O. Geoinformation Technology for managing environmental and natural resources for sustainability: the way forward for Africa. Conference on the Application of Remotely Sensed Data and Geographic Information Systems (GIS) in Environmental and Natural Resources Assessment in Africa. Harare March 15-22, 1996.
 11. Olson, M., Eastman, R., and G. Agyepong. Group Report on "Definition or needs and Capabilities on GIS for Decision-Making". AFRICAGIS'93 Documents. Tunis14 - 17June 1993.
 12. Rasheed, Sadig. "Sustainable Development in Africa in the 1990s and Beyond: Meeting the Challenge." *Environment and Sustainable Development in Eastern and Southern Africa: Some Critical Issues*. Edited by Abdel Ghaffar M. Ahmed and Wilfred Mlay. MacMillan Press Ltd. (London) 1998.
 13. Sliuzas R.V.. Incorporating GIS in urban planning and management in Tanzania. Second seminar on GIS and developing countries, GISDECO'93, Utrecht, June, 1993
 14. Woheren, Evans E. *Information Technology in Africa: Challenges and Opportunities*. ACTS Press. (Nairobi) 1993.