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Review

Biodiversity informatics in Eastern Africa: Status, drivers and barriers

Aime Tsinda[a,b,*], Roger Mugisha[a], Lillian Mutesi[a], Alfred Bizoza[a], Eugenia Kayitesi[a], Pamela Abbott[c]

[a] Institute of Policy Analysis and Research, IPAR, Rwanda
[b] University of Rwanda, Rwanda
[c] School of Social Science, University of Aberdeen, United Kingdom

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ABSTRACT

This article uses content analysis to review policies and relevant documents that promote or hinder the generation and use of biodiversity data in Eastern Africa. The review found that all countries in the region are committed to international and regional conventions that emphasize the protection and conservation of biodiversity. Some of the other drivers for biodiversity informatics include countries' national biodiversity related policies although there are few, which highlight the need for biodiversity data management systems. However, the existing policies are deficient in terms of policies for biodiversity data management. Suggestions to ensure the success of biodiversity informatics in East Africa include: (i) Avoiding overlaps but promoting complementarities within and/or between different institutions and stakeholders involved in biodiversity conservation; (ii) Putting in place clear, complete and simple policy documents pertaining to biodiversity data management.

Contents

* Corresponding author at: Institute of Policy Analysis and Research, IPAR, Rwanda.
E-mail addresses: aimetsinda@yahoo.fr, aime.tsinda@gmail.com (A. Tsinda).

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1. Introduction

Conservation and utilization of biodiversity directly depend upon the access to information (Agrawal, Archak, & Tyagi, 2012). Eastern Africa region is known to harbor rich and diverse biotic resources within the length and breadth of its territory. But data and information regarding these resources remain scattered within several organizations and individuals, making it difficult to easily and efficiently access adequate and accurate biodiversity information. Efficient access to data and information about these natural resources (both biotic and abiotic) and natural processes is essential for their effective conservation and sustainable use (Pettorelli, Safi, & Turner, 2014; Tandon & Bhattacharjee, 2010). Although biodiversity information is critical to a wide range of scientific, educational and governmental uses, it is often shaped by existence of adequate policy and institutional framework (Canhos, de Souza, De Giovanni, & Canhos, 2004; Guralnick & Hill, 2009; Nativi, Mazzetti, Saarenmaa, Kerr, & Tuama, 2009; Paton, 2009).

Biodiversity informatics is the computerized handling of information on biodiversity and its management and may include both processes and technology for data capture, curation, storage, analysis and visualization. It is a result of (i) increased awareness, (ii) various international agreements coming into force, (iii) availability of information in text, images, maps, videos as well as technology to record, link and archive such diverse types of information, and (iv) ever-increasing power of computers and internet to facilitate access and retrieval (Agrawal et al., 2012). Biodiversity informatics discipline encourages development of new tools, services and standards for data management and access, modeling, and data integration (Ariño, Chavan, & King, 2011; Peterson, Knapp, Guralnick, Soberón, & Holder, 2010). Biodiversity informatics draws upon many disciplines including systematics, ecology, and computer science.

An attempt has been made to take stock of progress so far made in the area of biodiversity informatics with a focus on four major categories:(1) Mobilizing Biodiversity Data, (2) Standards, Protocols, and Tools development, (3) Informatics Infrastructure development and (4) Capacity Building, Outreach and Open Access Initiatives.

With regards to collecting biodiversity data, there have been a number of initiatives undertaken in different regions of the world to mobilize biodiversity data, as this forms the basic constituent of all biodiversity informatics related activities (Baskauf, 2010; Hobern, 2013). However, although biodiversity contributes trillions of dollars to national and global economies and indirectly through biologically mediated services such as plant pollination, seed dispersal, grazing land, carbon dioxide removal, nitrogen fixation, flood control, waste breakdown, and the bio-control of crop pests (Maier et al., 2001; Metzger, Klaper, & Thomas, 2011; Schnase et al., 2003), most of the initiatives often focus on the developed countries and standardized systems of storing, managing, and sharing biodiversity data are still not well developed in Africa including Eastern Africa.

Furthermore, biodiversity is fundamental for the Earth's life support system, as it provides natural resources such as clean air, clean water, food, clothing, shelter, medicine, and aesthetic enjoyment. The natural resources often provide much essential natural service. Thus, biodiversity – the biological richness of ecosystems is perhaps the single most important factor influencing the stability and integrity of our environment, thereby continued existence of human civilization including political stability and economic development. It is in the interest of mankind that these resources are used in a sustainable manner, and cautiously, so as to ensure continued survival of the human race on this planet. Thus, it is necessary to improve access to existing and emerging sources of environmental, biological and socio-economic data, and improve integration of these data in support of disciplinary and interdisciplinary research efforts and applications and related policy-making initiatives in Eastern Africa (Canhos et al., 2004).

However, one of the challenges in achieving seamless, easy and efficient integration of these datasets is the development and deployment of tools, standards and infrastructure that can evolve interoperable framework. Towards this end, several initiatives are engaged in development of (1) standards and protocols, (2) collection and management tools, (3) geo-referencing and mapping tools, (4) data cleaning tools, (5) modeling tools, as well as (6) web services and computational frameworks. Considering the scope and expanse of biodiversity information, its spread, heterogeneity, these standards, laws and policies need to be documented in the context of Eastern Africa by identifying the gaps and avenues for further policies, protocols and standards required for integration of biodiversity and non-biodiversity data.

Efforts are on to build informatics infrastructure with exponential technological capacities, computational power, storage capacity and analytical ability. Post 1990, several global, regional, national, and thematic initiatives directly or indirectly contributed to evolving informatics infrastructure. However, this development is not equally distributed across the globe and East Africa and more generally Sub-Saharan Africa seems to be lagging behind.

Last but not least, open access to primary biodiversity data is essential both for enabling effective decision making and for empowering stakeholders involved with and affected by the conservation of biodiversity (Chavan & Ingwersen, 2009; Reichman, Jones, & Schildhauer, 2011). Efficient exchange of information has been recognized as one of the necessary preconditions for improvement of global biodiversity conservation (Laihonen, Kalliola, & Salo, 2014). However, many existing primary biodiversity data are neither accessible nor discoverable (Chavan et al., 2004; Moritz et al., 2011). Furthermore, there is scarce knowledge of legal, policy and technical factors that inhibit or promote human and institutional capacity in this domain.

It is against this background that this paper is structured around two main objectives: (a) investigate the policy and legislation frameworks, (b) analyze the institutional networks, in terms of their relevance to biodiversity informatics in four East Africa countries. Following this introduction, the next section elaborates on the methodology used. The subsequent two sections report and discuss the results. The final section draws conclusions and provides recommendations.

2. Methodology

2.1. Background on study areas

This study focuses on Eastern Africa and the countries purposely selected are Ethiopia, Kenya, Rwanda and Tanzania (Fig. 1). All countries are members of the Common Market for Eastern and Southern Africa (COMESA). Three countries (Kenya, Rwanda and Tanzania) are members of the East African Community (EAC), whereas, other two countries (Ethiopia and Kenya) belong to the Inter-Governmental Authority on Development (IGAD).These countries were selected because they are known to harbor intrinsic biodiversity potentials worldwide. This refers to the biological or ecological richness and factors favoring it, related to its physical, biological and environmental characteristics. These countries were also selected because there is a gap in knowledge on biodiversity data management.

While the politics of Ethiopia takes place in a framework of a Federal Parliamentary Republic whereby the Prime Minister is the head of government (Federal Democratic Republic of Ethiopia, 2013), the three other countries have a Presidential System of