Chapter 25
Assessing Environment–Climate Impacts in the Nile Basin for Decision-Making: Needs for Using Global Tracers*

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ABSTRACT

Assessing the environmental and climatic impacts in the Nile Basin is imperative for appropriate decision and policy making on national and regional levels. Tracer techniques provide basic spatio-temporal tools for quantifying ongoing and past, and for predicting future, environmental and climatic impacts in whole Nile Basin. These tools allow the sustainable use of the natural resources through developing appropriate large-scale and long-term management and planning strategies. Radiotracers, for example, have diverse properties, unique sources and cycles in the environment. They provide powerful approaches to understand the behaviour of atmospheric processes, and the role of dry and wet-deposition on transfer of matter from the atmosphere to the earth's surface. They are, also, useful for assessing the present status and evolution, as well as for quantifying the functioning and metabolism, in complex aquatic and land-water systems through appropriate definition of the spatio-temporal scales forcing their interactions with the environment and climate. They yield rich data on sources, pathways and flow-rates of matter (e.g. nutrients and pollutants) within and between landscape units and at the critical boundaries of the hydrosphere with the lithosphere, ecosphere and the atmosphere. Mitigation and adaptation strategies for coupled environment-climate policies require records and observations supported by model and forecasting infra-structures that can simulate the impacts of coupled environment-climate changes both on local and landscape scales. Impacts of global warming are not straightforward to predict unless reasonable scales can be used to compile and collate the diverse climatic and environmental data. Coordinated studies and observations of complex river-, lake-catchment, land-water and delta-coastal systems can provide a wide-range of information on human and climate impacts through using radiotracers as common time and space indicators for assessing the flow of matter on earth's surface. In this context, the Nile Basin can serve as a model for coupled environment-climate impact studies in complex aquatic systems where sustainable management policies, e.g. use of natural resources, protection and rehabilitation, are needed.

DOI: 10.4018/978-1-61520-907-1.ch025

INTRODUCTION

The quality of life on the earth depends on a continuous and dynamic flow of matter in its aquatic and ecological systems. Understanding the functioning and metabolism in these systems, in relation to space and time, depends to large extent on understanding the flow of matter in these systems: what are the important flows, how large and how quick? Which factors and processes regulate their dynamics, e.g. where, when and why these flows occur? This knowledge gives the necessary background to understand the evolution of aquatic and ecological systems and to forecast how these systems would respond to various changes in pollution, waste and climate.

An effective method to gain knowledge on these flows is to use radioactive tracers "radiotracers". Through their property to decay in regular manner they can be used as "clocks". Because of this and their dynamic flow and transportation pattern in the environment, studies of radiotracers can mark not only the dispersion of different compounds in space but also in time. The diversity of radiotracers in the environment, in terms of their origin (stratosphere, troposphere, hydrosphere), chemical (reactions under different conditions) and physical (half-lives, decay rates and modes) identities, allows to study different transport and accumulation processes influencing the cycling of nutrients and pollutants on the earth's surface especially what regards assessing the modern impacts of humans on nature.

A great deal of knowledge exists on the origin, transport, behaviour and fate of radiotracers in the temperate and polar regions of the world. This has allowed performing a wide-range of studies of the environmental conditions in these regions especially what regards the evolution, status and quality of life in aquatic and ecological systems. The situation in arid and semi-arid regions is very different and it exists a complete lack of data and knowledge on the environmental behaviour of radiotracers. Hence, the use and application of radiotracers for global and climate change studies is severely hindered in these regions. The Nile Basin, for example, has complex and dynamic flow of matter (for example nutrients and pollutants) with local, regional and global interactions. Understanding these interactions require comprehensive studies of radiotracers on several spatial and temporal scales in the whole Nile Basin. Resolving the natural and human components of these interactions, in terms of space and time, is imperative for implementing sound planning and management policies in this region. As for other parts of the world, radiotracers would provide elegant tools for identifying and quantifying environment-climate impacts in the Nile Basin. Description of the advances in nuclear metrology and the use of radiotracers in environment and climate studies and related applications are extensively discussed in a wide-range of literature and a full review on these issues is outside the scope of this paper. Examples on previous global applications of the radiotracers are referenced in this paper along with a brief survey of the state-of-the-art of the field as well as details on few studies and relevant demonstrations.

The contrasting landscape and climates of the Nile Basin, along with tracer tools, will give important data for the sustainable management of its land-water systems, and for understanding the global impacts of the climate. By correlating radiotracers with the behaviour of other compounds, under the different environment-climate regimes in this region, new knowledge on flow dynamics in complex land-water systems will be gained, e.g. evolution of water and air quality; dynamics of precipitation, dry-wet conditions and water circulation; dispersion of nutrients and pollutants; soil erosion, degradation of land, impacts of land-use, mining and industrial waste. These issues are central for long-term management policies especially in regions lacking the scientific and technical know-how for environmental protection. In the Nile Basin region, for example, there are huge needs for building the necessary scientific and