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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Water resource management

Managing sediment impact on SA's water resources

Towards an integrated framework for the assessment and management of sediment related impacts on water resources in South Africa: A dam performance case.

Background

Sedimentation is the direct result of the loss (erosion) of sediments from other aquatic areas or land-based areas. Sedimentation can be detrimental or beneficial to aquatic environments. Moreover, sediment impoverishment (erosion or lack of replenishment) in an area can be as bad as too much sedimentation.

Sedimentation in one area is linked to erosion or impoverishment in another area and is a natural process of all water bodies (i.e. lakes, rivers, estuaries, coastal zones, and even the deep ocean). This indicates that sediment management and control should be an integral consideration in any water resources development and protection strategy, as opportunities for truly effective solutions may also be inter-related.

Further, as the natural processes which determine the movement of water or sediments (or both) do not respect administrative boundaries, a holistic, river catchment-wide approach is frequently more appropriate than a local or national approach. Improved integration between relevant sediment management and water management objectives is therefore an important aim, and opportunities which contribute to both sets of objectives should be identified and exploited.

Managing sediment-related impacts

Assessment and management of sediment-related impacts on water resources is complex and multivariate, involving a careful balance of science, politics and economics. As is true for most such complex issues, there is not a single correct way to address the problem, but rather the approach should be driven by the ecological, political and socio-economic goals of all interested parties.

Moreover, because the choices made have far-reaching implications, it is useful for countries, regions or communities to develop standard integrated approaches for assessment and management of sediment related impacts to meet agreed-upon goals.

Although local and site-specific sediment related impacts are still likely to be the main scales at which interventions are made (i.e. dredging of a particular river reach), they need to be placed within a broader context and with full appreciation and consideration of their impacts within the catchment.

By considering the catchment as the prime morphological unit and scale for effective assessment and management of sediment related impacts, one of the most important requirements in the planning and decision-making processes, is the establishment of an integrated framework appropriate for sedimentation assessment, and management.

Integrated sediment management frameworks can help to understand the interactions, intersections, and information exchanges necessary to manage sediment sustainably. In the broadest sense, the conceptual framework should identify the relevant key environments (subsystems) within a catchment, and the interrelationships between the environments.

In particular, in the sediment management process the conceptual framework should help managers identify and evaluate the:

- various uses and users that interact with sediment in a catchment, and the relevant impacts;
- various environments within a catchment, and how they are impacted by sedimentation;
- sources of sediments and associated contaminants; and

- pathways, storage and fluxes of sediments and contaminants between these environments.

Sediment management frameworks

Sediment management frameworks for most catchments in the world have not yet been developed, or are not yet well established. This hinders sustainable management of sediments within the catchment.

Globally, the need for integrated sediment management frameworks has been recognised; however, very few countries have such frameworks in place. In 2011, all African countries lacked sediment management frameworks, except for Angola which falls in the category of countries with some sediment management framework, regulations, or project examples.

Neglecting to manage sediment in a sustainable way, either by lack of adequate sediment management strategies, or the cursory inclusion of sediment in generic policy and legislation, can result in costs to both society and the environment.

WRC project objectives

South Africa does not have a sediment management framework in place, nevertheless, a number of studies have been and or are being undertaken around sedimentation. These studies have dealt with site (problem)-specific cases regarding sedimentation; however, with the movement towards integrated management of water resources, it is necessary to collate the results of these studies to come up with a holistic understanding of the impacts.

This requires an integrated framework which will ensure that the assessment, and management methodologies for each site-specific are consistent with each other, and can therefore be easily integrated.

Hence, the purpose of this project was to develop an Integrated Framework for the assessment and management of sediment related impacts on water resources in South Africa. The framework was to incorporate source specific interventions, particularly aimed at regulating the activities responsible for sediment production coupled with strict monitoring.

The main objectives of the project were:

- To assess and review existing knowledge on sedimentation and management practices and frameworks in South Africa. This covered sedimentation, impacts on major rivers and navigation pathways, aquatic ecosystems, water supply systems (Lakes, rivers, reservoirs, dams), hydroelectric facilities, etc., from the quantity (yield), quality, efficiency, and sustainability perspectives.
- To identify and evaluate available models for integrated sediment assessment and management on a catchment scale. The models were assessed for their ability to perform sediment assessment and prediction, sediment impact and risk assessment as well as decision support. Based on the outcome a model was selected for use/improvement and recommendations made on development requirements for such a model. The model is expected to represent mathematically the main functions and uses of sediment, and the natural and anthropogenic influences and their impacts. The model will also be expected to cater for information and decision support system that houses the catchment data, and allows managers to analyse different scenarios for decision making.
- To develop a conceptual framework for the integrated assessment and management of sediment related impacts on water resources. Because sediments production are hydrologically, land cover, slope and soil type controlled the framework was developed to account for these factors at the catchment scale. The sediments impacts were assessed, ranked, prioritised and managed on the same scale. The framework presents the best process-based solution which takes account of the present source of sediments and institutional management frameworks.
- To develop a pilot study solution on a catchment scale that demonstrates the use of the framework, and sediment assessment and management model as part of the information and decision support systems. The case study included the application of the framework to depict relationships between the actors (both natural and anthropogenic) in the catchment; the application of the model to predict and assess sediment transport and impacts of sedimentation on the environment, hydrology and society; application of the information and decision support system to demonstrate how decision can be made the modelling results and/or under different possible scenarios in the catchment.

The proposed framework

Although there is a need to develop sediment management frameworks that can be used in any catchment, it is important to remember that each catchment is different and the complex role that sediment plays means that different objectives, pressures, impacts and mitigation measures will need to be considered in different catchments, and even in different sites within a given catchment.

Thus, a conceptual model may assist in identifying the need for site-specific assessment or catchment-scale assessment. In order for river catchments to be used as sediment management units, it is vital to have a conceptual model of river catchment functioning that links different areas in space and time, and allows potential consequences (impacts) of drivers to be evaluated.

The selection of the appropriate framework should be based on the specific aim(s) of the study and whether the framework fulfils the requirements of sustainable integrated sediment management and IWRM principles. This means an appropriate framework should be able to address sediment related problems at a river catchment scale while involving stakeholders in decision making throughout the whole process.

The aim of the study may either be managing the quantity and/or quality of sediments in a river catchment. Thus, frameworks that can be applied on river catchment scale, for example, the conceptual framework for river-catchment-scale sediment management or the DPSIR framework can be used in a study that is aimed at managing the quantity and quality of sediments.

If a framework is appropriate for a particular river catchment but it does not clearly incorporate stakeholder participation, it can be extended so as to include stakeholder participation and still be used in that particular river catchment.

The ultimate goal for the development of the Integrated Sediment Management Framework is to manage sediments sustainably. To be able to manage sediments sustainably there is a need for a sediment management plant (SMP) on a catchment scale, and this must also be incorporated into a catchment management strategy.

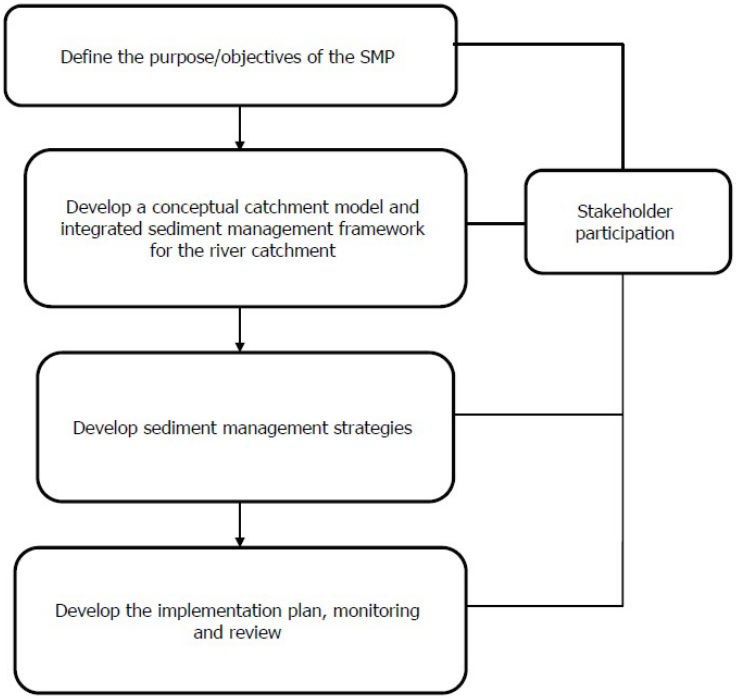
An SMP is required to achieve a balance between fulfilling sediment management objectives, and the need to secure human activities and legal requirements. To be effective, the SMP must be technically sound and practical, environmentally sensitive, politically realistic and financially feasible and sustainable.

Developing a sediment management plan (SMP) will provide guidelines for more effective management of sediment resources, recognizing they are part of a regional system involving natural processes.

The SMP seeks to achieve the following four objectives:

- Identify erosion/deposition problem areas in the catchment;
- Identify principal sources of sediment in the catchment;
- Identify alternative methods of reducing erosion rates; and
- Evaluate and recommend methods to reduce impacts resulting from sediment erosion and deposition.

Below a simplified guideline showing the steps to be followed in the development of SMP.



Guideline for developing SMP

Recommendations

Based on the conclusions it is recommended that:

- In a South African context, the unavailability of a national guiding principles on sediment management is seen as a challenge to the implementation of the integrated Sediment management framework, and it is therefore recommended that as a first step South Africa should develop high level policies to guide the various organs of the state in managing sediments sustainably.
- Management of sediments spans a number of independent institutions, hence for an integrated approach to be successful, there must be an institutional co-operation strategy and a committee that will facilitate engagements between the various institutions. Hence further research should be geared towards identifying the key role players in sediment management and development a co-operation strategy.

- Sediment Management Plans should be developed and incorporated into the catchment management strategies as a matter of urgency.
- Researchers, policy-makers and community education have to go hand-in-hand to face the problems of land degradation and soil erosion as the successful implementation of soil conservation measures and road drainage control is only possible through a combination of socio-economic, political, and scientific considerations.
- There must be community education and awareness about the long term consequences of human interference into their natural environment as people understand their present impact on the future productivity of their land.
- There must be a development of conditions to be used in initial site selection for the project such as select a site that is suitable rather than force the terrain to conform to development needs. This will ensure that development features follow natural contours.

Further studies should be undertaken in view of improving the relevance of the Framework for all catchments in South Africa. What would also be important would be to add an economic model to assist with the choice of strategies relative to the implementation cost.

Further reading:
To order the report, *Towards an integrated framework for the assessment and management of sediment-related impacts on water resources in South Africa* (**Report No. 2064/1/13)** contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.