January 2012

TECHNICAL BRIEF

IWRM

The new sediment yield prediction map (2010 Edition) has been published by the WRC.

Prediction: The key to sedimentation management

Elevated sediment concentrations in rivers and sediment deposition rates in reservoirs are currently having marked effects on land and water resources in southern Africa. Water quality in rivers and reservoirs has been degraded by suspended sediment and reservoirs have lost significant proportions of their original storage due to sedimentation. Since reservoirs provide storage of water for drinking, irrigation, recreation, hydropower production and flood control, sedimentation has resulted in serious economic losses as well as environmental and aesthetic problems.

It is therefore very necessary to consider erosion and sedimentation issues in the planning and design of proposed dams, reservoirs and water resource projects. In order to meaningfully manage sedimentation in rivers and reservoirs, there is a need to understand, define, quantify and/or predict catchment soil erosion and sediment yield.

Revision of sediment prediction methods

Over the past fifty years South Africa has, through practical experience and research, built a rich knowledge base relating to erosion and sedimentation. It is from this knowledge base that the problem of reservoir sedimentation has continuously been analysed. Sediment yield prediction methods have needed continual revision in the wake of changing environments, more data, advanced analysis tools, increased experience and technological advancements in the sedimentation field.

The most recent revision of sediment yield prediction methods took place during the course of updating the ***Sediment Yield Map of Southern Africa***, first produced in 1992 by Rooseboom and co-workers. Revision focused on the prediction of sediment yields from un-gauged catchments in South Africa and Lesotho.

Revised sediment yield prediction methods were based on analytical approaches and mathematical modelling with a view to using them in planning and management of water resources, particularly with regard to reservoir sedimentation control at a catchment scale. The catchment erosion and sediment yield modelling methods lend themselves to application in:

- the temporal and spatial analysis of catchment sediment yields, from the point to the catchment scale, and
- the production of results that are essential for the identification of critical erosion areas, sediment sources and formulation of catchment management strategies.

Revision approaches

The development of the revised sediment yield estimation methods involved collection of data, refinement and calibration of national erosion hazard potential data, preparation of electronic copies of erosion hazard potential maps, computation of sediment yield values, delineation of ten relatively homogeneous sediment yield regions, regional analysis and assessment of data and generation of catchment area erosion hazard potential statistics.

The proposed Polihali Dam in Lesotho was selected as a case study to illustrate the role and application of mathematical modelling in sediment yield prediction within a catchment. Observed sediment yields were calculated from reservoir sediment deposition data and river sediment sampling. The relationships between sediment yields and the variables that affect the generation of sediments yields were investigated.

The sediment yield prediction methods that were developed and incorporated into the revised ***Sediment Yield Map of Southern Africa*** (2010 edition) include probabilistic, empirical and mathematical modelling-based methods.

The probabilistic method was developed using statistical analysis of regional data of observed sediment yields and soil erosion hazard based on the earlier research of Rooseboom and co-workers. The empirical method, based on the total input stream power, was developed from regression analysis of variables that control sediment yield with respect to the South African conditions, namely floods, soil erosion hazard, river network density, catchment area and river slopes.

Outcomes

Both the probabilistic and empirical methods were validated in each of the ten delineated homogeneous regions. From the results, it was possible to determine which of the methods performed better and yielded the better results in each of the regions.

Based on this, the probabilistic approach is recommended for three of the homogeneous sediment yield regions, the empirical method for six other regions whilst, for the remaining region (Lesotho Highlands), it is recommended that sediment yield prediction be based on direct measurements and locally observed data, since no meaningful analysis of sediment yield values was possible due to poor and limited data.

Both the probabilistic and the empirical methods allow for the pre-setting of confidence bands within which sediment yield predictions can be made.

An investigation of the application of SHETRAN and ACRU as erosion and sediment yield models showed that the models can be successfully used to simulate sediment yield in a catchment, subject to calibration and validation against observed sediment loads. To enable this, proposals have been made for systematic sediment monitoring in rivers and dams through sediment sampling and reservoir surveys, respectively.

Future research directions

There is a need for more research into the prediction of sediment yields in ungauged catchments, especially to follow up indications that sediment storage could have a significant impact on sediment yield in some South African catchments. Even though quantification of sediment storage is problematic in general and especially so in large catchments, future research into the role of sediment storage should provide better insight into the relationship between computed values of gross erosion and observed sediment yields. Such research would also establish whether the possible depletion of sediment storage capacity in some catchments would trigger larger sediment yields than those currently predicted.

Future research on predicting sediment yields should also take into consideration the potential impacts of climate change on sediment loads and sediment yields. Increased flooding linked to climate change would in future present greater challenges to water resources management with respect to sediment control. Regions susceptible to increased sediment loads due to flooding would need to be identified and appropriate mitigation measures investigated.

Further reading:
To obtain the report, ***Sediment Yield Prediction for South Africa (2010 Edition)*** (**Report No: 1765/1/10**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za