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INTEGRATED FLOOD MANAGEMENT (IFM) STRATEGIES FOR A TIDAL RIVER BASIN: A CASE STUDY OF TUTONG RIVER BASIN DEVELOPMENT IN BRUNEI DARUSSALAM

K. B. M. Shafiuddin[1&2]
1. *Institut Teknologi Brunei*
2. *MIEAust, CPEng, MASCE, FIEB*

ABSTRACT: Integrated Flood Management (IFM) aims at sustainable development under the risks of flooding minimizing loss of life and property, maximizing the efficient use of flood plains, using the residual flood flows for irrigation and leaching and restoring and maintaining river health and associated eco-system and environment. Tidal nature of a river adds yet another dimension/parameter to it for integration of soil and water quality and quantity issues required for sustainable irrigated agriculture and agro-industry. Traditional flood management is a short-sighted mono-disciplinary 1D model approach having persisting shortcomings. In its practice in Tutong river basin, traditional flood management only focusses on how to quickly get rid of the flood flow. The ever increasing and emerging new challenges require a multi-disciplinary approach of IFM adoption. River Tutong can be termed as a tidal estuary having salt water intrusion affecting some 25 kilometers in the basin hinterland and severely affecting agriculture and waterworks. There is plenty of rainfall in the basin almost round the year, yet rain-fed paddy and other crops do suffer for lack of water in between the rainfall events. Farmers have abandoned agriculture from the otherwise arable lands that require irrigation water of quality and quantity from the river. The IFM for the Tutong river basin requires special attention of more of a Integrated Water Resources Management (IWRM) approach. This paper reviews and attaches special attention to redraw the traditional stand-alone approach of flood management for Tutong river to be remodeled into an elaborate and effective IFM suitable for Tutong River Basin (TRB). Besides the normal flood disaster, preparedness and proofing events, it would also address the socio-economic, environmental, land and water development, navigation, aquaculture and eco-system issues pertaining to basin development including public participation. The Tutong river IFM pre-feasibility study recommends that a major tidal sluice may be built at or near the confluence to the sea with adequate flood flow passage. Coupled with IWRM approach the flood water management in the basin should include peak flood flow passage for flood mitigation, on-stream storage of residual flood flows for compartmentalization and irrigated agriculture. The use of the residual flood flow for irrigation and waterworks can be achieved by on-stream storage and controlled release of flood flow. Infrastructure development, institutional management with public participation and construction and operation of control sluices at strategic locations would play a vital role for overall success of the basin development. Tutong river that appears to be a sorrow of the basin could potentially be converted into a basin of joy.

Key Words: IFM, IWRM, flood flow, residual flood flow, public participation

1. INTRODUCTION

Integrated Flood Management (IFM) integrates land and water resources development in a river basin, within the context of Integrated Water Resources Management (IWRM), with a view to maximizing the efficient use of flood plains and minimizing loss to life. Thus, occasional flood losses can be accepted in favor of a long-term increase in the efficient use of flood plains.

Multi-stakeholders engagement is a key to the success of IFM as it ensures strong stakeholder support and is a catalyst for proactive engagement in flood issues.

Traditionally, flood management has focused on controlling floods in terms of draining flood water as quickly as possible to the next water body, store flood water temporarily, or to separate the river from the population in terms of river engineering works. Another emphasis has been on emergency response and recovery once a flood occurs.

Even though the declared goal of such efforts has been to reduce economic losses due to floods, there is an overwhelming body of evidence that suggests that floods can never be fully controlled. It is now widely recognized that a paradigm shift is required from defensive action and flood control to the integrated management of floods.

The need for this paradigm shift is the inspiration behind the concept of Integrated Flood Management, which seeks to integrate land and water resources development in a river basin within the context of Integrated Water Resources Management (IWRM) in order to maximize the net benefits from flood plains, with flood risk awareness, and minimizing the loss of life and property.

2. THE IWRM CONTEXT

For flood management to be carried out within the context of IWRM, river basins should be considered as integrated systems. Socio-economic activities, land-use patterns and hydro-morphological processes need to be recognized as constituent parts of these systems. A consistent approach needs to be applied to all forms of possible intervention. The entire hydrological cycle is considered rather than differentiating between floods and droughts when planning water resources development.

IWRM, as defined by the Global Water Partnership (GWP), is “a process which promotes the coordinated management and development of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems”, is based on the recognition that a single intervention has implications for the system as a whole. More positively, integrating management means multiple benefits may be achieved from a single intervention.

While it is not possible or feasible to totally eliminate the flood risk, it should be recognized that floods also have some positive impacts. The challenge is to manage them as part of natural occurrences and take advantage of the beneficial aspects. This is in line with current thinking and the concept of Integrated Flood Management, which shifts away from fighting floods towards managing risk and integrating flood control with other urban systems. For example (Akmalah, 2006), in Jakarta where most of the communities are adjusting to flooding, the approach should be focused on community resilience rather than costly total flood control. Since stakeholder participation is integral to the IFM concept, it is imperative that all stakeholders are involved in the decision-making processes that affect flood management.

2.1 Implementation of IWRM

Operationally, IWRM approaches involve applying knowledge from various disciplines as well as the insights from diverse stakeholders to devise and implement efficient, equitable and sustainable solutions to water and development problems. As such, IWRM is a comprehensive, participatory planning and implementation tool for managing and developing water resources in a way that balances social and economic needs, and that ensures the protection of ecosystems for future generations various uses of water demand coordinated action e.g. for agriculture, for healthy ecosystems, for people and livelihoods—demands coordinated action.

An IWRM approach is consequently cross-sectoral, aiming to be an open, flexible process, and bringing all stakeholders to the table to set policy and make sound, balanced decisions in response to specific water challenges faced. An IWRM approach focuses on three basic pillars and explicitly aims at avoiding a fragmented approach of water resources management by considering the following aspects:

Flood disasters, which involve complex interactions among natural events, geomorphologic conditions, and human interventions, add greatly to the hardships of low-income people in developing countries. Although floods are triggered by natural events, the hazards they present are also affected by the social, economic, and political environments where people live. Low-income people suffer most from flood disasters because they tend to live in flood-prone areas, often do not understand the hazards they face, and lack institutional support (Akmalah, 2006)

2.2 IWRM as a process

IWRM should be viewed as a process rather a one-shot approach -one that is long-term and forward-moving but iterative rather than linear in nature. As a process of change which seeks to shift water development and management systems from their currently unsustainable forms, IWRM has no fixed beginnings or endings. Furthermore, there is not one correct administrative model. The art of IWRM lies in selecting, adjusting and applying the right mix of these tools for a given situation. (Biswas et al, 2005). The aim of IFM is to put in place well-functioning integrated measures for flood management. For this, the linkages between various relevant sectors become very important.

Some of the cross-cutting conditions that are also important to consider when implementing IWRM are:

- Political will and commitment
- Capacity development for end users as well as for implementing agencies
- Adequate investment, financial stability and sustainable cost recovery
- Comprehensive monitoring and evaluation

3. TUTONG RIVER BASIN

Tutong river is located some 50 km from Bandar Seri Begawan, the capital city of Brunei Darussalam. It originates from the hilly catchment carrying heavy flash flows. It is a tidal river and salinity affects about 25 km from the confluence affecting valuable agricultural land.

The Tutong River Basin (TRB) as a whole is being effected by adversities of flood damages by flash flows, drainage congestions, inadequate irrigation application for lack of infrastructures and water sources and thus failing in the agro-projects specially rain-fed paddy schemes.

Tutong River flows uncontrolled and saline water intrusion during high tides made it into a saline river historically damaging standing crops and lands by flooding and salinity.

The basin gets abundant rainfall in its hilly catchment generating flash flow flowing down the stream untapped and finally wasted to the sea and yet agriculture, especially rain-fed paddy suffers for lack of fresh water irrigation during dry spells. The outfall being uncontrolled, saline water easily intrudes and makes agriculture all the more difficult due to salinity.

Much of the areas that are arable but not suitable for cultivation, because of the acidic nature and saline conditions due to tidal effect and continuous intrusion of saline sea water, irrigated agriculture did not develop much to the requirement of the country. Farmers are abandoning the cultivation practices and moving elsewhere for better income.

Uncontrolled flash flows cause severe damages to crops and property. Some flood mitigation projects are being implemented on stand-alone basis by relevant government departments without considering and integrating the other aspects of water issues like over-drainage, storage of residual flood flows on stream for irrigation requirements for agriculture and agro-land reclamation by leaching the saline-damaged agri-fields. This scenario has to be reversed for the best interest of the country in general and for TRB in particular. Public demand is very strongly felt for infrastructure development of irrigated agriculture using residual flood flows stored in the streams

3.1 The study of TRB

A recent study concluded (Shafiuddin, 2014) and its findings strongly recommended for integrated feasibility studies for flood mitigation, irrigated agriculture, infrastructure development for the numerous rain-fed projects that suffer for lack of irrigation and drainage and damage of standing crops by flash flooding. This pre-feasibility level of engineering study achieved the aims of:

- Recommending possible remedial solutions for flood mitigations, efficient project drainage and supplementary irrigation for rain-fed paddy schemes for more than one crop a year
- Identifying the sustainable water resources development potentials and constraints in the areas of irrigation, drainage and flood control for the basin with focus on irrigated agriculture and growth of agro-industry without adverse effects on environment and eco-system.
- Investigating and identifying the effects and present extents of salinity intrusion issues and adversities in the uplands of Tutong river due to profound tidal effect for the basin as a whole,
- Examining the potential of agro-land reclamation by long term leaching with one way flashing of undesirable salt contents in the arable lands.

The study also finally recommends a multi-disciplinary and detailed feasibility studies involving agriculture, socio-economic, environmental and ecosystem for the possible sustainable integration of the development components.

3.2 IWRM study of TRB

River Tutong is tidal and it traverses into the hinterland some 25 km to the valleys and meadows that are mostly cultivable lands. With success of IWRM and implementation thereof, the entire TRB would be a sweet water zone ideal for irrigated agriculture to flourish tremendously.

Integrated Water Resources Management (IWRM) modelling and study of the project is essential. The planned activities of IWRM studies would, therefore, address the manifold issues of the basin and recommend most of the following sustainable and integrated engineering remedies looking into the following:

- Flood Mitigation ensuring safe passage of flood flows
- Dry Flow Augmentation & residual flood flow Storage
- Drainage and flood Control for Agro-projects/industries infrastructure
- Salinity Intrusion Control and land reclamation with structural measures
- Sediment Transport Issues relating to river capacity reduction studies

The following issues may also be studied to strengthen integration:

- There is riverine traffic prevailing in the river course in the valleys and close to the outfall and would need to be maintained
- Fisheries Development would be essential to maintain the existing sweet water fish culture.

- Environmental Issues, (EIA) and Effects of Climate Change (water sector) which is now considered to be an umbrella assessment for any project to initiate and complete.

The benefits and outcomes would be manifold in structural and non-structural form, namely:

- Overall water resources development would convert the basin into a fresh water zone and flood free compartments by control structures at strategic locations and infrastructure development,
- Facilitate Irrigation, Drainage & flood mitigation and salinity control with little or no adverse effects on the environment and eco-system.
- Motivate farmers for farming and agro-industries for food security
- Generate employment and overall sustainable rural uplift

4. RECOMMENDATIONS AND CONCLUSIONS

This IWRM research and studies recommendations for TRB will focus on the integrated approach on various feasibility aspects of water resources development including socio-economic, environmental and eco-system issues. Outputs and outcomes will be achieved through research and study findings on various existing schemes that would need development, improved infrastructures with no salinity effects. The recommendations from the recent TRB study findings (Shafiuddin, 2014) are as follows:

- The study identified an area of roughly 12200 ha affected by salinity intrusion (Ref: Fig. 1)
- A major tidal sluice may be built at or near the confluence to the sea with adequate capacity for peak flood flow passage (Ref: Fig. 2)
- The sluice should be robust and structurally strong enough to sustain the passage of peak flood flow over it.
- Few intermediate storage controls by weir construction at strategic locations of the river for storage of residual flood flow (Ref: Fig 2).
- Stopping of saline water intrusion will convert the entire TRB into a sweet water zone conducive for irrigated agriculture to flourish significantly.
- Possibility of reclamation of agri-land would be high through continuous long term leaching effect.
- There will be rain water harvest as the residual flood flow be stored on the upstream of the sluice up to the river bank levels. This would facilitate maintenance of the environmental balance and eco-system conservation for healthy river system
- Construction and operation of few secondary control structures/weirs/sluices at strategic locations would play a vital role for overall success of the basin development.
- Residual Flood flow storage study indicates that there would be enough storage available for irrigation of rain-fed paddy that suffer from lack of irrigation in the dry spells between two rainfall events. (Ref. Fig. 3)
- Flood mitigation by compartmentalization would also be possible through the networks of existing random drainage systems and more importantly by stake holder participation which is one the themes of IWRM. A sustainable Flood Management would be achieved for the TRB

- The possibility of sweet water fish culture would enhance in the TRB.

- A long term sub-soil leaching activity would commence for agro-land reclamation by unidirectional flow of sweet water.

- In case of extreme dry spells, the residual flood flow storage would facilitate sub-irrigation and controlled drainage depending on the extent of drought.

- Infrastructure development, institutional management with public participation and more importantly, there would be significant employment generation with vibrant rural economy

From the engineering point of view, this is quite a long list of possible benefits if, of course, they survive through the economic evaluation of cost–benefit ratios and thus declare the project to be attractive, economically viable and technically feasible.

Multi-disciplinary approach of study methodology is to be adopted to consider inputs from all relevant disciplines, namely, engineering, agriculture, fisheries, marine transportations, socio-economics, environmental and eco-systems each conducting their respective studies and experiments required in their own way.

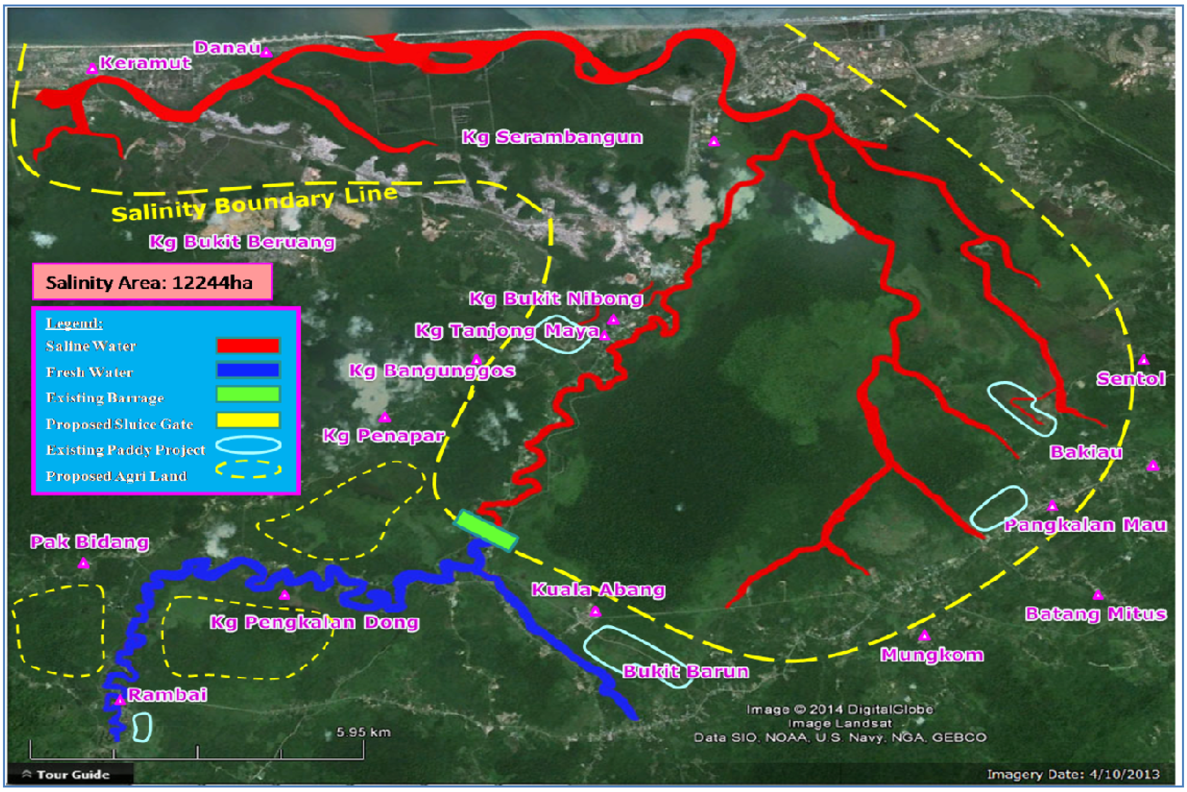


Figure 1 Tutong River before Salinity Control

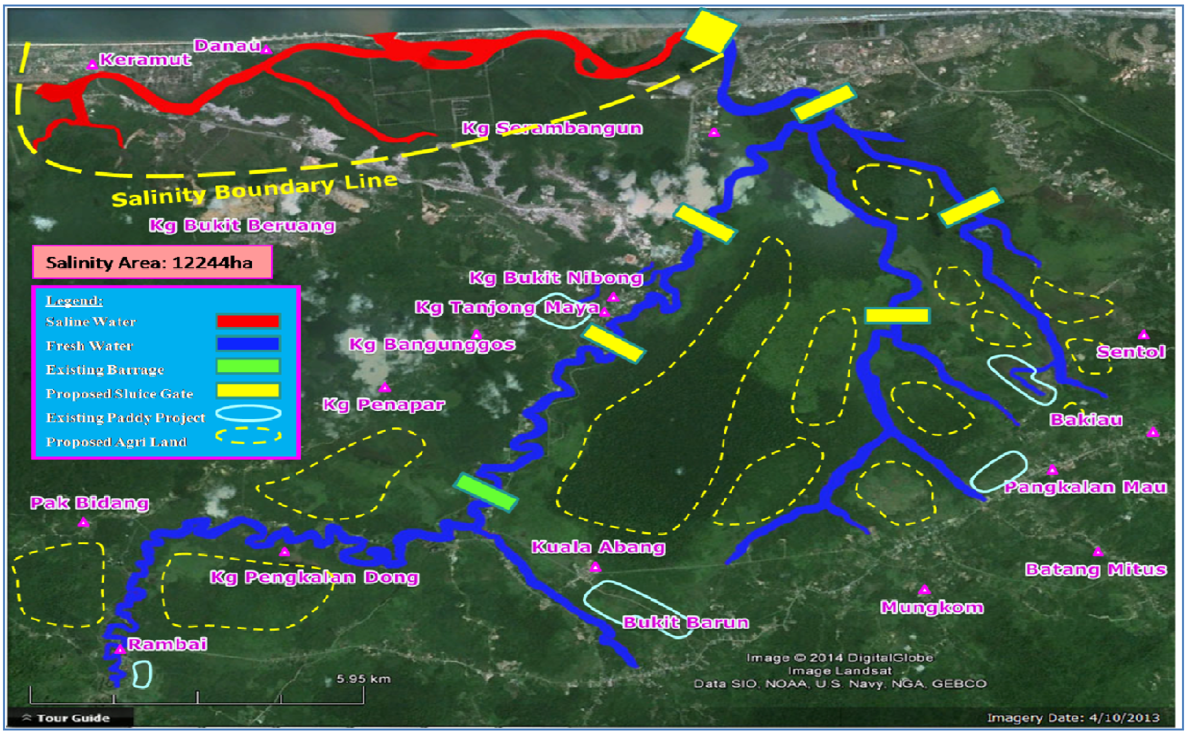
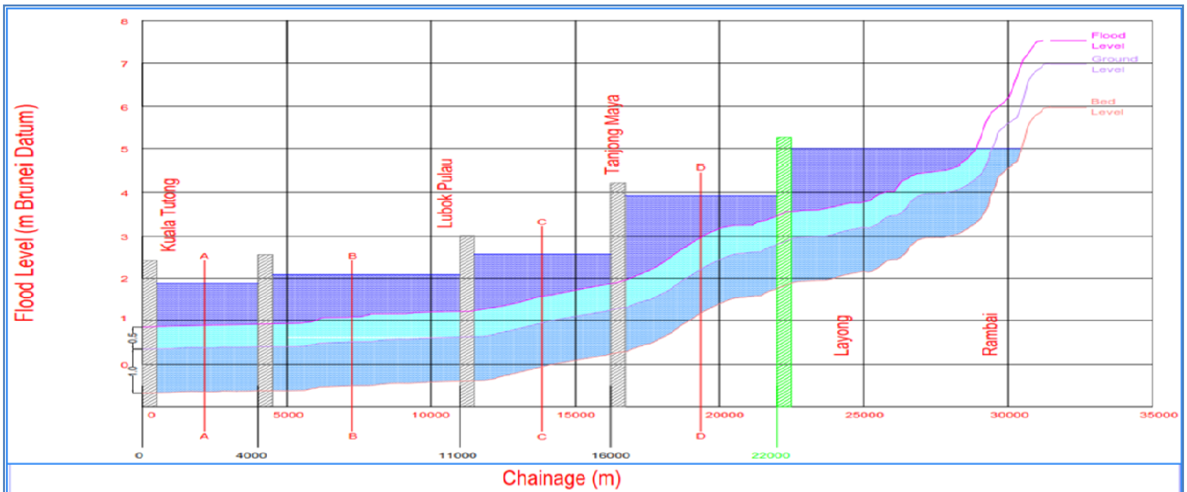


Figure 2 Tutong River after Salinity Control



CROSS SECTION	A-A	B-B	C-C	D-D
AREA (m^2)	220	152	152	158
DEPTH OF FLOW (m)	2.5	2.6	2.6	2.7
LENGTH (m)	4 000	7 000	5 000	6 000
STORAGE VOLUME (m^3)	881 500	1 062 915	759 225	950 010
LONGITUDINAL SLOPE (1 in)	80 000	30 000	8 000	4 000
IRRIGATION WATER AVAILABLE (m^3/s) *	2.55	3.08	2.20	2.75

Note: * Based on 4 days continuous drought

Figure 3 Tutong River Longitudinal Profile showing Control Structures and Storages

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