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CASE STUDY

FIJI ISLANDS: *FLOOD MANAGEMENT - REWA RIVER BASIN*

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1. Introduction

The Fiji Islands comprise of over 300 islands, 109 of which are permanently inhabited. The majority of these islands lie between longitudes 176^0 50'E and 178^0 W and latitudes 16^0 S and 20^0 S (Fig 1). The total land area of 18 272 km^2 is dispersed in territorial waters of 141 800 km^2. The two main islands, Viti Levu and Vanua Levu support majority of the population of 775,077[2]. All major economic activities are based on these two islands.

The islands are of volcanic origin and rise to an elevation of over 1000m asl with perennial rivers and streams. The eastern windward side supports a natural tropical rainforest and the drier leeward side is extensively cultivated with sugarcane and pine forest.

The islands are dominated by the Southeast trade winds. Average annual precipitation over the Fiji Group ranges from 1500mm on smaller islands to around 7000 mm on elevated large islands. The principal influences on the seasonal rainfall pattern are tropical disturbances and cyclones. The El-Nino Southern Oscillation phenomenon is known to intensify these effects.

1.1 Location

The Rewa River on the island of Viti Levu, runs from the central high lands to the south east. The river has narrow flood plains running into the hills in the middle and upper catchment. At the lower reach the river meanders and in the delta splits into several tributaries. Flood plains along the river and the delta (latitude 17^0 52'S to 18^0 01'S and longitude 178^0 14'E to 178^0 32'E) are prone to floods (fig 2).

1.1.1 Physical features

The island has a central mountain range (Nadrau Plateau) with a general north-south orientation generally dividing the island into the leeward dry western and windward wet eastern area. The plateau has 29 peaks of over 900m, with mount Victoria, the highest, rising to 1,323m. Rugged mountains with perpendicular cliffs and pointed peaks are common on the plateau. The middle catchment has well-rounded hills with elevation of 300 to 600m. Alluvial plains are narrow and they merge into the hills. Two thirds of the way down stream the river plain widens and the river sprawls over a delta. The flood plains and delta are fertile which supports agricultural crops and a dense population. The urban population of Nausori Town is 5744 and an additional 15,873 people live in the peri-urban area[3]. The watershed including the delta has a population of approximately 196,000 people.

On the coast there are mud flats with mangrove bordering the sea. The coast is generally protected from wave action and to some extent storm surge by the mangrove forest.

The climate is humid tropical and the mean annual rainfall over the catchment varies from around 2 000 mm in the lower reaches to well over 5 000 mm on the higher elevated interior of the island. The mean rainfall over the catchment is in the order of 3 500 mm. The catchment is exposed to Southeast trade winds. The spatial and temporal distribution of rainfall is non-homogeneous with strong seasonal and inter-annual variations. The wet season from November to April is also the tropical cyclone season. An average of 15 tropical cyclones affects

[1] Director, Suva Water Supplies, Samabula, Fiji
[2] Population figures from 1996 census
[3] 1996 census figures

the country each decade. The wet season receives up to 80% of the annual rainfall and the 20% during the dry season is non homogeneously distributed over the period May to October. Temperatures range between 20^0C and 30^0C with relative humidity between 65% and 75%.

The drainage system comprises of five major tributaries (fig 3). The Waimanu and Waindina drain the western coastal region, the Wainimala drains the central high lands and the Wainibuka runs from the dry north east portion of the island. The catchment area is 2960 km^2 at Nausori Bridge.

The gradient of the riverbed is very gentle from the mouth to the middle reaches and abruptly gets steep in the upper reaches (fig. 4). Rapid lifting of the hills in the upper reaches or sudden regression of sea level normally causes such forms of riverbed. The doming and uplifting is reported to have taken place in recent geological age (early Pliocene) 4.5 to 5 million years ago.[4]

Tropical Cyclones are the principal cause of major floods. Rainfall begins while the centre of the cyclones is still some distance out at sea. As the tropical cyclone approaches rainfall intensity increases. Rapid runoff from an already saturated catchment results in extensive floods. Other severe weather events with high intensity rainfall also cause floods but these are of lower magnitude and less frequent

Mean discharge of the river at Navolau (catchment 1960 km^2) upstream of the tidal zone is 74 m^3/sec with a maximum of 2810 m^3/sec and minimum of 24 m^3/sec. Peak discharge during tropical Cyclone Kina flood was around 7 000 m^3/sec at Navolau downstream at Nausori the peak discharge was in the order of 18 000 m^3/sec (catchment 2960 km^2).

The upper reach of the catchment is mountainous with steep rock outcrops; the less steep weathered slopes support a dense tropical rain forest. Forest covers as much as 70% (2,174 km^2) of the catchment. Landslides, which supply much sediment, are common during severe weather conditions. The foot hills and middle catchment has deeply weathered soils with tropical vegetation and some agricultural activities. Flood plains in the lower reaches have several metres of fertile soil deposits.

The Rewa Delta formed by meandering river and sediment deposited over geological time is protected on the coast by mangroves. Water logging in the delta region was common until the recent drainage works.

1.1.2 Land and water use patterns

Riverbanks and flood plains in the middle and lower reaches are extensively cultivated. Cultivation on slopes is not uncommon. Some dairy farms are located on the undulating zone with grazing extending to the riverbanks.

With relatively steep slopes and deep weathering soil erodibility in the catchment is generally high. The erodibility of grassland and grazing along the Waininbuka in the upper reaches can be classified as severe. Severe erosion also results from cultivation of high value ginger crops grown on slopes throughout the catchment. Free draining slopes are best suited for selected high value crops.

Cultivation extends to the delta, with extensive areas under crops. Rice cultivation once dominated the region with pump irrigation. The major pumped irrigation system has recently closed due to low productivity and high costs of pumping in favour of dry land farming.

[4] Rodda P. 1984

Nausori Town in the southern part of the catchment is a commercial centre with some developed industrial area supporting light industries and a rice mill along the Kings Road. A number of schools together with a hospital and government administration offices are located within the town. The early residential development within the town boundary is rapidly expanding into the peri-urban area on either side of the river. Newer residential development extends to the east, west and south of the town (fig.5).

The Nausori International Airport just south of the town is linked by road through to Suva, the Capital City, via the Kings Road. A wastewater (sewerage) treatment facility catering for the town and surrounding area is located on the raised riverbank between the airport and town.
The northbound Kings Road runs in the lower reach and the east of upper catchment. A road runs through the centre of the catchment to Tavua with a branch that runs west through Namosi to Navua.

Within the catchment there are two major water supply intakes, both located on the southern most tributary (Waimanu) of the Rewa. Water treatment facilities are located away from the flood plains on high ground and access is by road across the flood plain.

While forestry, cultivation and heavy agricultural activities lie within the domain of men, women tend to nurturing young crops, harvesting and preparation of commodities for the market. Women are principally responsible for taking care of and raising chicken and ducks for home consumption. One or two house cows for milk is not uncommon on small farm holding. Tending these together with draft animals is shared responsibility between the genders and sometimes the children.

Women traditionally fetch water and assist in gathering fuel wood and some food. The waterways provide aquatic food. Fish, eels, prawns, shrimps and shellfish are the principal source of protein for many. Further cash from sales of fresh water mussels found in the middle and lower reaches of the river is an important source of income. It is mostly women who gather and market freshwater mussels.

Construction of a seawall (85Km) along the coast on the delta has opened up some 13 000 ha of previously saline land for cultivation. Some 40 floodgates prevent seawater intrusion and helps drainage of excess water. Plots of land that were water logged have come under production. Fill material dredged from the rivers has been used to raise depressions that collected rainwater with the delta region.

The improvement in drainage and prevention of seawater intrusion has improved production of crops, while the seawall has provided easier access in some areas. Life for both men and women has thus improved.

Land use changes are generally to cater for agricultural expansion over the fertile flood plains. It extends into the hills. Clearing of forest to make way for expansion has continued unabated. Ginger is predominantly grown on freely draining hill slopes. With favourable returns and increasing demand for ginger together with other food crops for the local and export markets cultivation has gradually but persistently extended on to steeper slopes.

New farms to meet the fresh produce requirements have been developed over undulating land encroaching onto the hills. Forest harvesting has continued with development of some farms in forest cleared areas. Other activities such as grazing have also expanded in the upstream area as well.

Up to 1960 the Colonial Sugar Refining Company transported sugarcane by barges to a sugar mill on the bank of the Rewa River in Nausori. The river was dredged for navigation during the

dry season. Poor quality of sugar due to wet conditions forced the mill to close. Rafts for down stream transport of banana was used until the crop production ceased due to blight infestation in the early 1960s.

Currently only a limited number of small private open punts with out board motors are used for inter village transport within the delta area and some small off shore islands. Small fishing boats navigate between Nausori commercial centre and the open sea.

At the lower reach river water is drawn by pumps for the Suva - Nausori reticulated water supply system. It serves more than 100 000 people with water that is filtered and disinfected. The Waimanu pump draws and average of 36 000m^3 /day while the pumping station located at Waila pumps 90 000 m^3 /day (fig. 3).

A rice irrigation scheme on the bank of Rewa River (Lakena) has now converted to dry land farming. Individual private farmers using portable pumps draw an insignificant amount of water from the rivers. Watering of farm draught animals and livestock from the river is insignificant as well.

With abundance of water almost throughout the year, there is no major use of above mean annual flow. Water is plentiful in the wet season and the dry season requirements are generally met without any critical shortages or ill effects.

The Monasavu hydro-dam is the only storage facility that captures water during the wet season to meet the continuous requirements during the dry season. Flow from small adjacent catchments is drawn in to the dam via a tunnel. In recent years water shortage has been experienced because of the increase in energy demands and high inter-seasonal variation in rainfall.

Floodwaters are a menace. It is not utilised but drains out to sea. The demand for large storage facilities is not pressing. During the dry season usually there is adequate moisture for agriculture and other water requirements are met from existing sources.

It is only during occasional prolonged dry season (drought) that water shortage is experienced. These are infrequent. Some exploratory work has been carried out to determine the possibility of constructing multipurpose retention dams. There is no urgency or pressing demand for storing large quantities of water.

2. Description of floods

2.1 Type of floods

Large floods are induced by tropical cyclones. On average, 15 tropical cyclones affect Fiji each decade and each one causes high intensity rainfall (Raj 1997). The magnitudes of floods are dependent the tropical cyclone system, its distance from land, its intensity, its angle of approach and its movement and speed.

Flash floods are restricted to smaller sub catchments. They are infrequent, localised and damages are limited to a smaller area.

Storm surges exacerbate flood levels on the coastal zone. When the eye of the tropical cyclone passes close to shore or traverses land storm surges are inevitably generated. The amplitude of these surges depend on the intensity of the cyclone, its proximity from the shore, angle of approach, the coastal bathymetry and shape, tide conditions and the prevailing atmospheric pressure. Floodwater discharge is restricted and river banks are often breached. Seawalls are over topped with large storm surge (fig XY).

2.2 Incidence of extreme events and a very brief description of historical flood Events
Major floods (1983 to 2003) that affected Fiji with damages and lives lost is tabulated.

Flood damages in Fiji caused by some recent TCs and Floods

Tropical Cyclone	Year	Lives lost	Damages million F$	Damages in Million $ US[5]
Oscar	1983	9	148	80
Eric	1985	25	64	35
Gavin	1985	7	2	1.2
Sina	1990	----	33	17
Joni	1992	1	2	1.1
Kina	1993	23	188	100
Gavin	1997	12	35	19

Source: World Bank study

Tropical Cyclone Kina flood (Jan 1993) followed a severe drought induced by the El Nino event of 1992/93 was the most severe in recent history. Three major bridges were destroyed and road transport around the island was disrupted. In the Rewa watershed two hospitals had to be evacuated apart from the many from private homes and property. People from the urban, peri-urban and rural areas sustained damage and losses. Across the country more than 120,000 people (approximately 10% of the population) suffered serious losses and had to be supplied with food rations for up to six months to cope with the disaster.

The 1983 Cyclone Oscar and the associated floods had similar impact but lower losses and damages (table above). This could be due to lower investment in flood prone localities 10 years earlier. The experience and lessons learned has been useful.

2.3 Brief description of flood disasters
The cost of damages and the loss of human lives indicate the magnitude of flood disasters encountered. Agricultural crops are damaged or lost completely; livestock are swept away by floodwaters. Damage to roads and bridges (wash outs, landslides and slips) make access difficult if not inaccessible. Transport not only to the markets but also to schools for children and medical facilities for the injured and the ill are affected.

Damage to residential properties, health facilities, schools, public buildings and infrastructure is sustained. Patients from two hospitals had to be evacuated during the Cyclone Kina floods and the 29 evacuation centres had a total of 4337 evacuees. After the floods around 75 000 persons had to be supplied with food rations.
These losses have serious social and economic implications. Relief and rehabilitation costs are high. The national GDP and government's development plans and programmes are adversely affected. Resources earmarked for capital development works have to be urgently redirected for relief and rehabilitation.

2.4 Brief description of differential impact of any flood disaster on women and men
All communities and both genders are affected, in the urban and rural communities and across all sectors. While women have to bear with the difficulty of maintaining hygiene for the family especially the young and infirm, men are burdened with the additional responsibility of

[5] Approximate figures as exchange rates varied over the years.

rehabilitating their property and crops. The loss of crops not only impact income but health as well. Nutritional deficiencies have been identified particularly in women and children following disastrous events. Road access can be disrupted.

3. Flood management measures

Structural measures of river dredging, construction of seawalls and floodgates reduce the impact of floods by increasing the drainage capacity of the river. thus Floodgates prevent salt-water intrusion.

Non-structural measure (flood forecasting) provides the communities at risk an early warning of the impending threat. It gives time for those under threat to take action by moving property and livestock to safety and where necessary prepare for evacuation.

It is not an integrated system and improvement in catchment management and appropriate land use strategy is desirable.

3.1 Flood management measures in Fiji and strategies that are in place to manage floods within the context of IWRM

Dredging of the riverbed is the major structural measure. The river has been dredged to increase flood discharge capacity. The low gradient of the riverbed (fig 4) in the lower reaches of the river system has high sedimentation. Some 10 million cubic metres of material have been dredged from the river. It is used for construction of roads, buildings and raising village sites to provide relief from floods.

A number of drainage schemes in the low lying flood prone areas have been established by the Regional Drainage Board. A network of drains and out-fall structures (floodgates) are designed to enable floodwaters to escape and prevent seawater entering.

Forecasting of impending floods has been effective in fore warning and allows for the movement of movable property including livestock to safety. A flood forecasting system is in place and has operated well for the last two decades.

These measures are intended to lead to an integrated flood management system. Cautious planning and improvement in land and water use, including the imposition of restrictions is necessary for integrated flood management.

3.2 Mechanisms in place for the effective use of floodwaters and floodplains

Plentiful supply of freshwater does not warrant use of floodwaters yet and no mechanisms are in place for use or storage of floodwaters. Only the hydropower dam captures a relatively small amount of flood water, otherwise all floodwater is discharged to the sea. There is no urgent demand for large volumes of water during the dry season.

The flood plains with established infrastructure (roads, electricity, and communications) and the fertile soils are attractive for cultivation and settlement. Most developments on flood plains are subjected to flood damage. Only in Nausori town the levee of the river has been developed into a park. Some, albeit small areas that have suffered frequent floods are dedicated for grazing. Similarly some farmers have though experience restricted flood prone lowlands to grazing or cultivation of flood-tolerant crops.

In many low-lying areas the Department of Agriculture through the Drainage Board, a statutory authority has improved and maintains a network of drainage system. It helps prevent water

logging and assists rapid drainage. The Drainage Board levies a charge to land users[6] to meet the maintenance and operation cost of the drains and associated infrastructure.

At the river mouth along the delta sea walls prevent seawater intrusion into farmland. Out fall structures or flood gates prevent sea water entering but discharges floodwaters out to sea. Some 40 flood gates and 85km of sea wall are in place along the coast.

3.3 The efficacy of these mechanisms

Dredging of the river provides some relief and will arrest flood problems. Watershed management particularly reduction of soil erosion and sedimentation needs attention. Restrictions on use of flood plains, hill slopes and generally improved land use practice will assist in flood mitigation.

Although the current flood forecasting system provides for mitigation and loss prevention it can be improved with longer lead-time. Quantitative precipitation forecasts (QPF) if and when available could be used to increase forecast lead-time. There is a desire to develop QPF capability but currently constraints in infrastructure and resources[7] are difficult to overcome.

3.4 Flood mitigation measures

Dredging the river to increase the discharge capacity is effective but high sediment loads call for costly continual dredging. Watershed management with the view of reducing erosion and sedimentation needs to be targeted.

A network of drains maintained by the drainage board has been effective (fig 5). However during the dry season the drains get infested with weeds, which are washed into the floodgates that exacerbate flood problems.

Flood forecasting has been effective. Early warnings of impending floods alert the habitants. Moving live stock and moveable property to the safety of higher ground and evacuation of people to evacuation centres have effectively reduced damage and losses. Because of the short lead-time of floods (6 to 8 hours) adequately phrased alerts and when possible warnings are issued while there is daylight for mitigation measures to be effective. Experience has shown that movement out of flood prone localities to safety at night can be hazardous in itself. This early forecast requirement can lead to reduced confidence of forecasts and warnings.

Restriction on land use and cropping is only by persuasion and there are no authoritative regulatory provisions to affect such measures. Both structural and non-structural measures are used but no quantitative analyses of the economic benefit of the individual mitigation measures are available.

Flood forecasts and warnings call for the participation of both men and women. Men are involved in collecting perishable food from the gardens, moving property and livestock to safety and women are active in preparing household essentials and readying children to move out of flood danger once warnings are issued.

3.5 Modifications to flood mitigation measures following extreme flood events

Following each flood an assessment of the impact of the event is undertaken to assess the damages and identify the need for improvements. The efficiency of structures such as drainage systems and floodgates are reviewed for any rehabilitation or improvements.

[6] Land users are owners or lessees
[7] Human and financial resources are limited and radar coverage is limited.

In most cases the immediate requirements such as rehabilitation of shelter and infrastructure including roads, water supply and electricity take on higher priority. Within the private sector the more innovative sometimes identify high ground within their property to drive their livestock. Some are even known to go to the extent of raising existing safe areas for livestock by bulldozing soil to make small hillocks.

Surveys are undertaken to establish the river bed to determine dredging requirements. Flood forecasting operation system is reviewed to establish the sensitivity and accuracy including the communication system and function of remote stations. Recalibration of the forecast model may be undertaken.

New measures are restricted to identification of flooded areas and escape routes, identifying new evacuation centres, strengthening infrastructure and improving techniques of forecasting. Identification of flood prone danger zones for future restrictions. There has not been any significant shift in the relative importance of each of these measures. Under the social, cultural, economic and weather conditions priorities and emphasis are difficult to move.

Real or near real time data on water levels and rainfall is collected from a network of six hydrology stations by radio telemetry at a central base Office. A computer model makes forecasts of river levels at flood prone locations. Reports received of river levels at certain locations, flooded roads, bridges and crossings by telephone directed at relevant authorities are made available. Regular update from the National Meteorological Service on the location, intensity, movements and direction of tropical cyclones is received in regular bulletins, which is very helpful.

The Hydrology Section of PWD makes its own continual assessment of the situation using all available data and information.

There is heightened co-operation while data and information on the occurrence, magnitude and time of the flood event is sought. There are also discussions amongst authorities on ways to improve mitigation measures, improve timeliness and accuracy of forecasts. Soon after the event the National Disaster Management Office brings all interested parties together at a debriefing meeting.

4. Flood and water management instruments

The National Disaster Management Act of 1998 gives authority and provides institutional arrangement for all activities related to disaster management and related activities. The Act defines the functions and duties of government and relevant agencies in relation to natural disaster management and related matters.

The Act stipulates the establishment of a National Disaster Management Council (NDMC) that is chaired by the Minister responsible for disaster activities. Through the same legislative authority the NDMC is supported by a National Disaster Management Office and three committees. The Emergency Committee has the central control during emergency operations, the Preparedness Committee is responsible for community awareness activities and the Mitigation and Prevention Committee initiates and co-ordinates the implementation of disaster mitigation activities.

4.1 Legal aspects of flood management with respect to: a) land use in the catchments as well as floodplains; b) flood warning; c) disaster preparedness and response

Most of the land in the catchment is owned by indigenous land owning units. There is no specific legislation to restrict land use although a proposed National Land Use Plan has been prepared by the Ministry of Agriculture Land Resettlement and Sugar. The Land Conservation

Board through an old Land Conservation and Improvement Act (Cap141) has powers to place restriction on land use but this has never been applied for flood mitigation.

The Disaster Management Committee is triggered into action at the formation stages of tropical cyclones or other severe weather conditions. Fiji Public Works Department (hydrology section) provides flood forecasts which are communicated to the NDMO by fax/telephone for the public.

The Disaster Preparedness Committee conducts a one-week disaster awareness program before the onset of the cyclone season annually. It plans, promotes and implements disaster preparedness activities using the mass media. Public at large and school children are targeted to propagate messages.

4.2 Allocation and use of resources for integrated flood management

There are no resources allocated specifically for IFM.

4.3 Access and control of resources for women and men

The ministry responsible for Disaster Management Activities has annual budgetary provision to finance disaster management activities, including preparedness, prevention, mitigation, emergency response, rehabilitation, long term recovery and related activities. The budget for 2004 is $15,000. Resources for gender specific activities are not identified separately.

4.4 The efficacy of law enforcement mechanisms, incentives and sanctions

Limitation or restriction in the rural areas is almost non-existent. There is no legislation to restrict land use. It is only through persuasion and/or repeated losses and damages that flood prone localities have restricted development. The insurance industry plays a regulatory role by increasing or not accepting insurance for properties and developments in flood prone areas.

Development of land particularly for housing and residential subdivision requires the approval of the Town and Country Planning. They may place restrictions on development and / or require improvements. However use of land for agriculture in flood prone localities does not have restrictions.

5. Institutions responsible for flood management

5.1 Agencies involved in various aspects of flood management, briefly

The Land and Water Resources Management (LWRM) of the Agriculture Department is responsible for river engineering, drainage and irrigation activities. They provide bank protection services and are active in the coastal and riverine area. Together with Public Works Department they are responsible for flood control and water shed management.

PWD Hydrology is responsible for flood forecasting[8]. Flood forecasts are issued and disseminated through the NDMO for specific localities[9].

5.2 The extent to which institutions involved in flood management cooperate with each other

The major players responsible for flood management are the LWRM of the Ministry of Agriculture and the Public Works Department (PWD). They have an amicable working relationship.

[8] Only the Rewa River has a telemeterd flood forecasting system
[9] Individual areas within the river basin

Meteorological data and information is freely available from the Fiji Meteorological Service stations through out the country.

5.3 Authority and co-ordination of activities of the institutions

Cabinet is the final authority and all relevant institutions are government departments. There is no central authority as such; however, during disaster the National Disaster Management Office plays a central coordination role.

5.4 Interest and Involvement of interest groups involved in flood management activities

The interest groups are the LWRM, PWD, NDMC and the communities of flood prone localities. The victim communities are the beneficiaries of the different flood mitigation measures in place. They participate initially by offering suggestions, identifying historical flood levels and later by observing warning and making appropriate arrangements to overcome flood disaster. Both genders participate.

6. Policy

6.1 Policies on water resources management, flood management, land management, development planning and disaster prevention and response.

Fiji's water legislation is fragmented and out dated. A national water policy for Fiji is in the process of being drawn with cabinet approval up by an interim national water committee consisting of multi-ministerial and departmental stakeholders.
National Land Use Plan has been developed and legislative instruments for monitoring and execution is required. It will place restrictions on rural land use to encourage prudent land use. A sustainable development bill has also been drafted for legislation to support a comprehensive sustainable development policy.

The National Disaster Management Act, 1998 is in place. It provides for the performance by government and relevant agencies of their functions and duties in relation to natural disaster management activities and related matters.

6.2 Policy and stakeholders participation

These policies were developed after much consultation and reviews, which included participation of experts, government and non-government organisations, private and public sector representatives.

6.3 Policy changes in response to extreme flood events

The policies have been developed after repeated disastrous events affected Fiji in recent years. Loss of lives, economic losses, social disruption and set back to development caused by the urgent redirection of development funds for relief and rehabilitation has resulted in the development of comprehensive policies on disaster management. Sustainable and economically viable solutions and policies are continually explored.

6.4 Policy changes and integrated water resources management

The set back to development and the costs involved in rehabilitation works poses serious financial burden for a small developing economy. Integrated water resources management that will address issues of floods and droughts while meeting national development goals is an attractive option. A model River Basin Management involving all stakeholders for Nadi is proposed. Support from ESCAP for the project within the framework of Integrated Water Resources Management (IWRM) is in an exploratory stage.

7. Lessons learned

Flood management requires an integrated approach to address all issues in a holistic manner. Issues related to land and water resources use need to be planned and executed in a manner that will reduce or eliminate risks.

Community co-operation and participation is essential for the success of flood mitigation programmes. The Drainage Boards include members of different communities from different areas as the beneficiaries. With beneficiaries having ownership of the scheme support for changes, improvements and reviews are undertaken with enthusiasm.

Public awareness and education on the application of IFM is necessary. Full community participation with ownership needs to be supported with strengthened institutional arrangements and resources.

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