INTEGRATED FLOOD MANAGEMENT IN SAMOA

From Science to Policy

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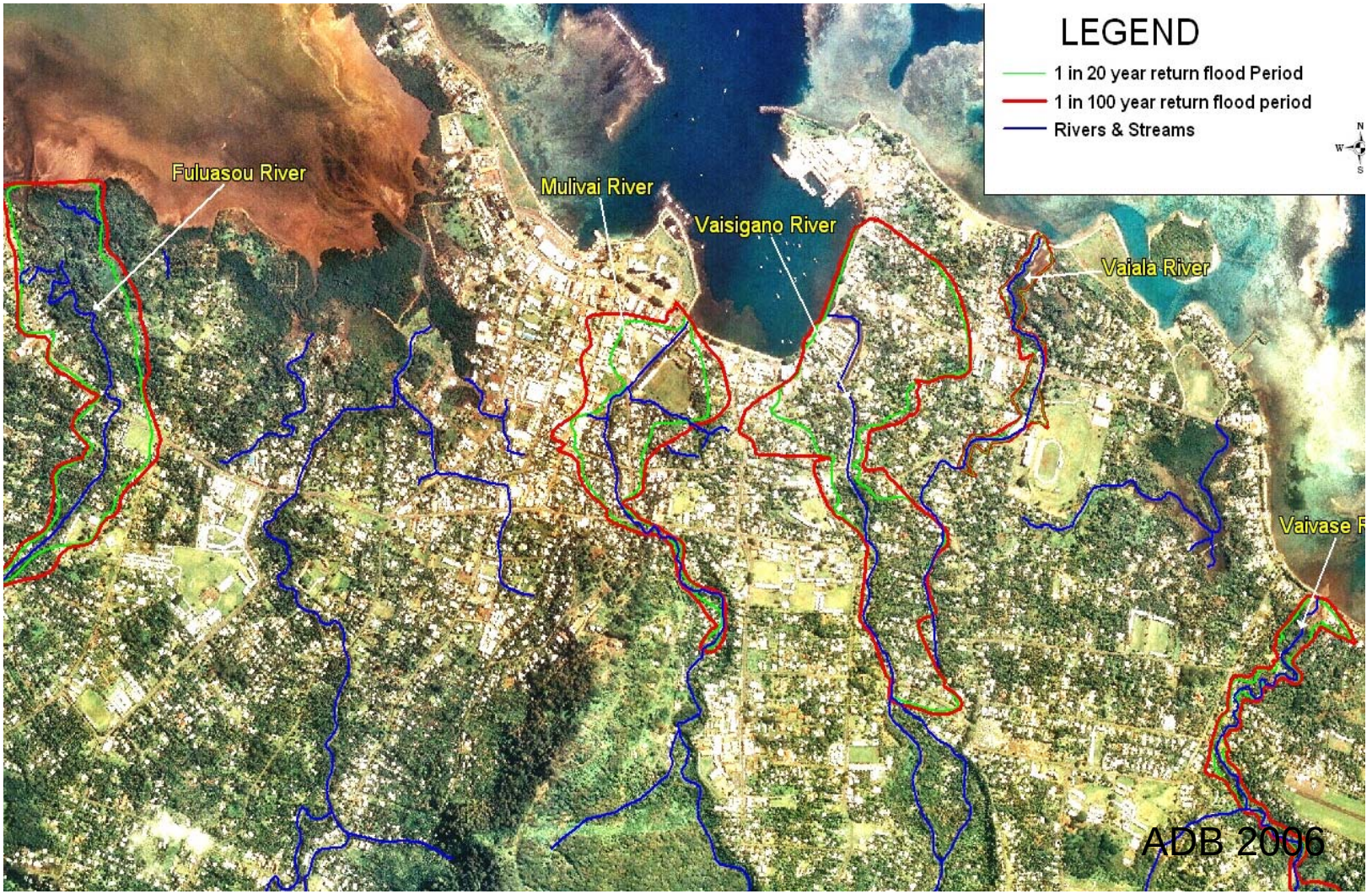
Why Flood Management?



Why……issues

- Health risks (waterborne diseases)
- Lack of coordination and integrated planning among agencies that should be responsible for flood risk reduction
- Lack of town planning in Apia - many commercial and residential properties are developed on floodplain
- Weak monitoring and early warnings to communities at risk
- Constraints in budgetary allocation to mitigation activities
- Limited capacity (staff number & skills)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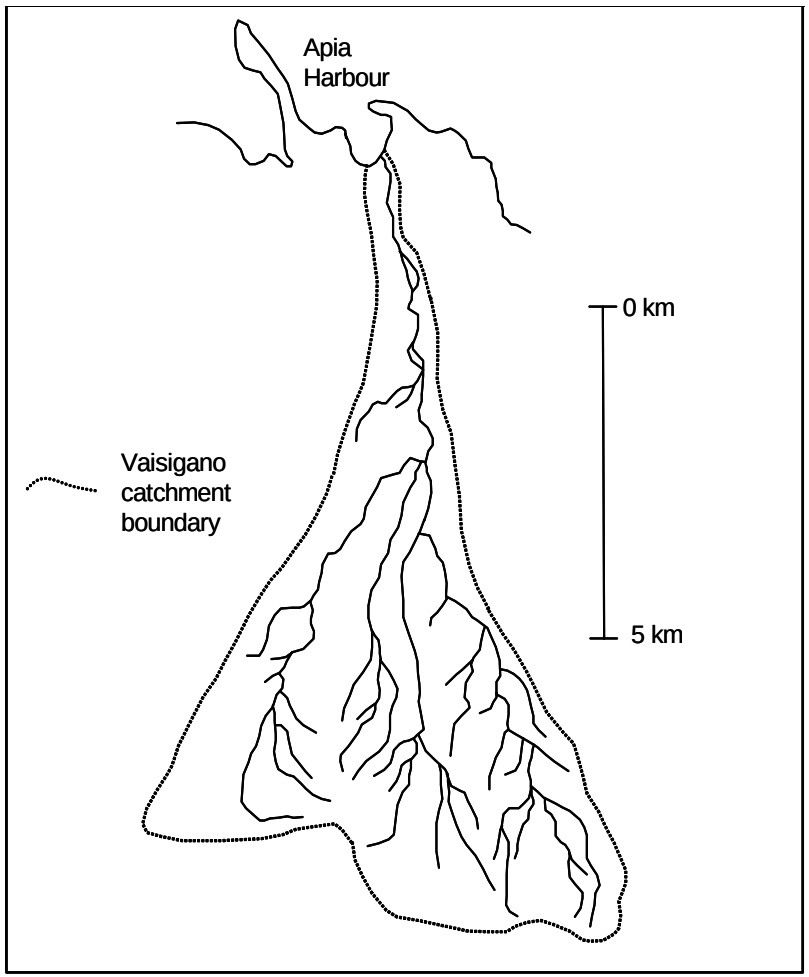
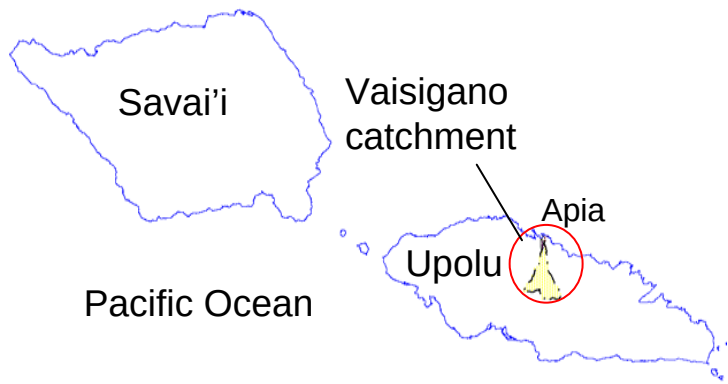
Process Applied

- Development part of SOPAC/EDF8 *Reducing Vulnerability* Project
- Capacity Building in Flood Hydrology, River Modelling and Flood Mapping
  (from data capture to analysis and modelling)
- Development of Rainfall/Runoff and Flood Inundation Models
- Production of Flood Hazard Maps
- Evaluation of Flood Management Options
- Development of Policy Documents
  - Flood Management Action Plan 2007-12
  - Floodplain Management Guidelines
- Benefit-Cost Analysis of Mitigation Options

Geographic Scope



- Flood management process is countrywide
- Pilot: Vaisigano River
  - flow records available
  - drains into Apia,
  - largest basin on Upolu
  - 35 km^2
  - IWRM Hotspot



PART I

Science

Data Constraints

- Only 22 years of Annual Max Flow
- Many gaps due to equipment failure or lost records (e.g. TC Ofa)
- Available flow gauging only up to 1/10 of peak flood flows
- Only limited intensity data available in 100+ year rainfall record
- High degree of uncertainty in estimated flood flows ~ ± 20%

Estimation of Peak Flow

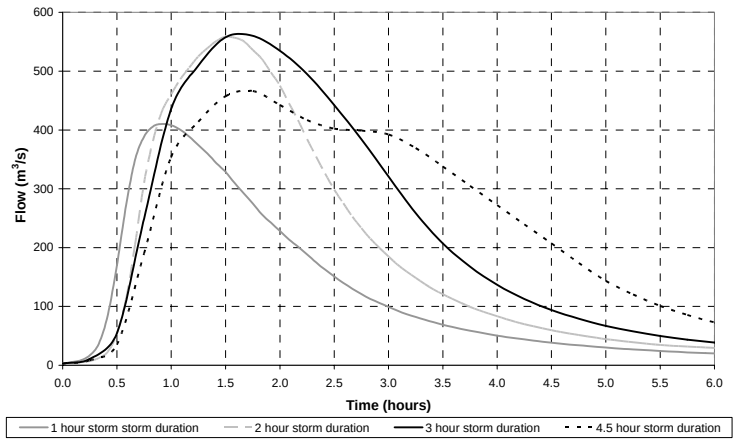
Method	1 in 100 yr (m^3/s)
Statistical single site analysis (22 yrs)	
Revised rating curve	656
Weir equation	181
Regional flood frequency analysis	
MAF based on revised rating	411
MAF assuming higher 2001 flood flow	461
MAF based on weir equation	253
MAF based on regression for Pacific basins	636
Rainfall – runoff modelling	
HEC-HMS kinematic wave model	560
HEC-HMS SCS lumped model	564

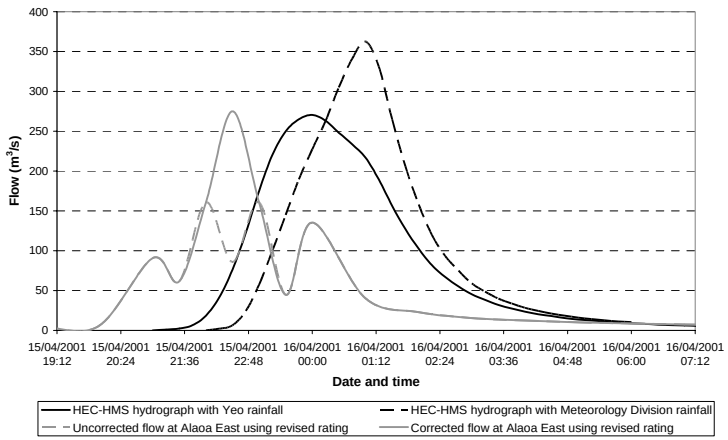
Hydrograph and Design Storm

- Critical storm duration for flooding is 2-3 hrs
- Estimated rainfall intensities (mm/hr):

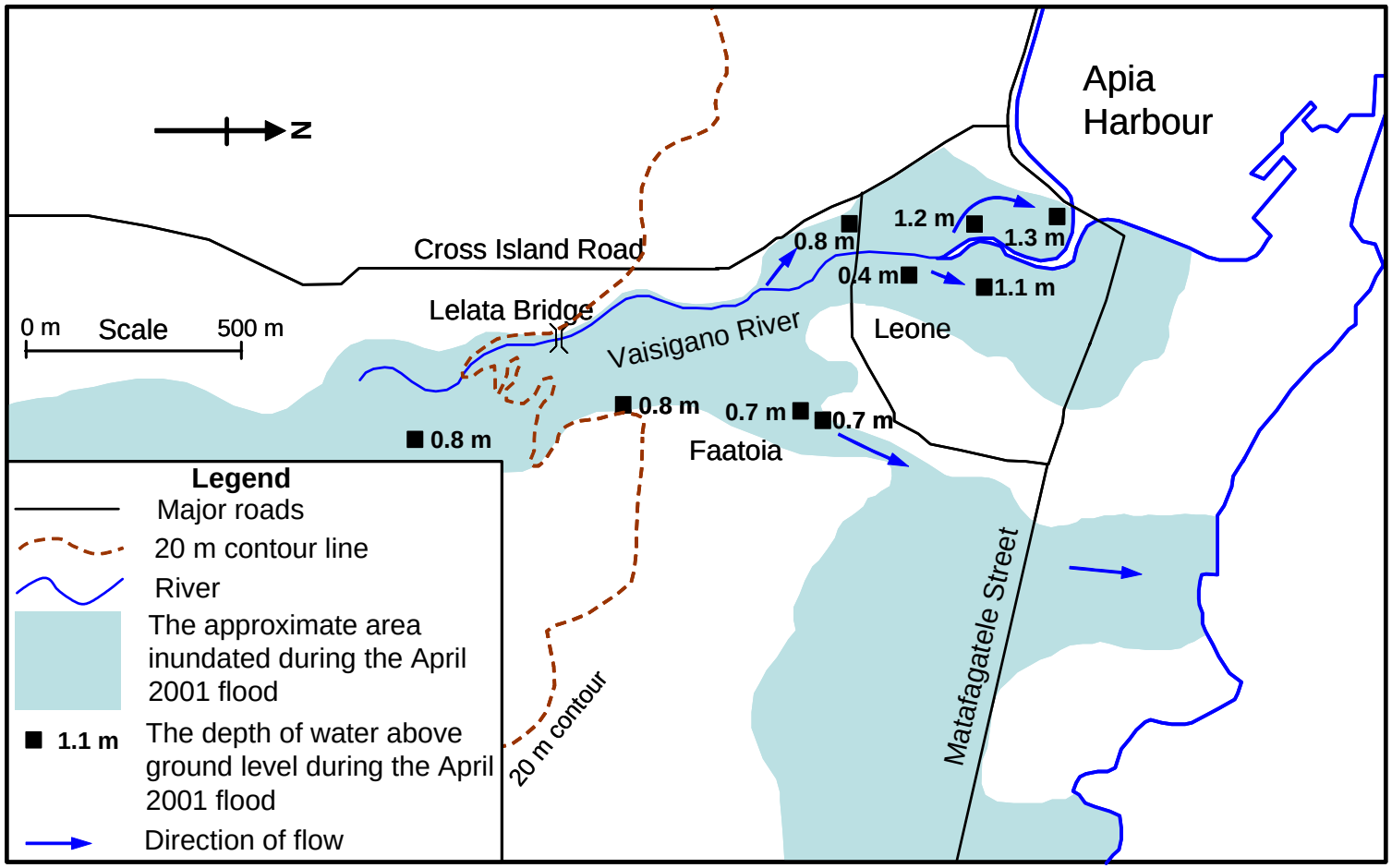
Duration (hr)	1 in 10 years	1 in 50 years	1 in 100 years
2	**66**	**80**	**87**
3	**47**	**57**	**62**

- Sparse calibration data available from 2001 and 1974 events



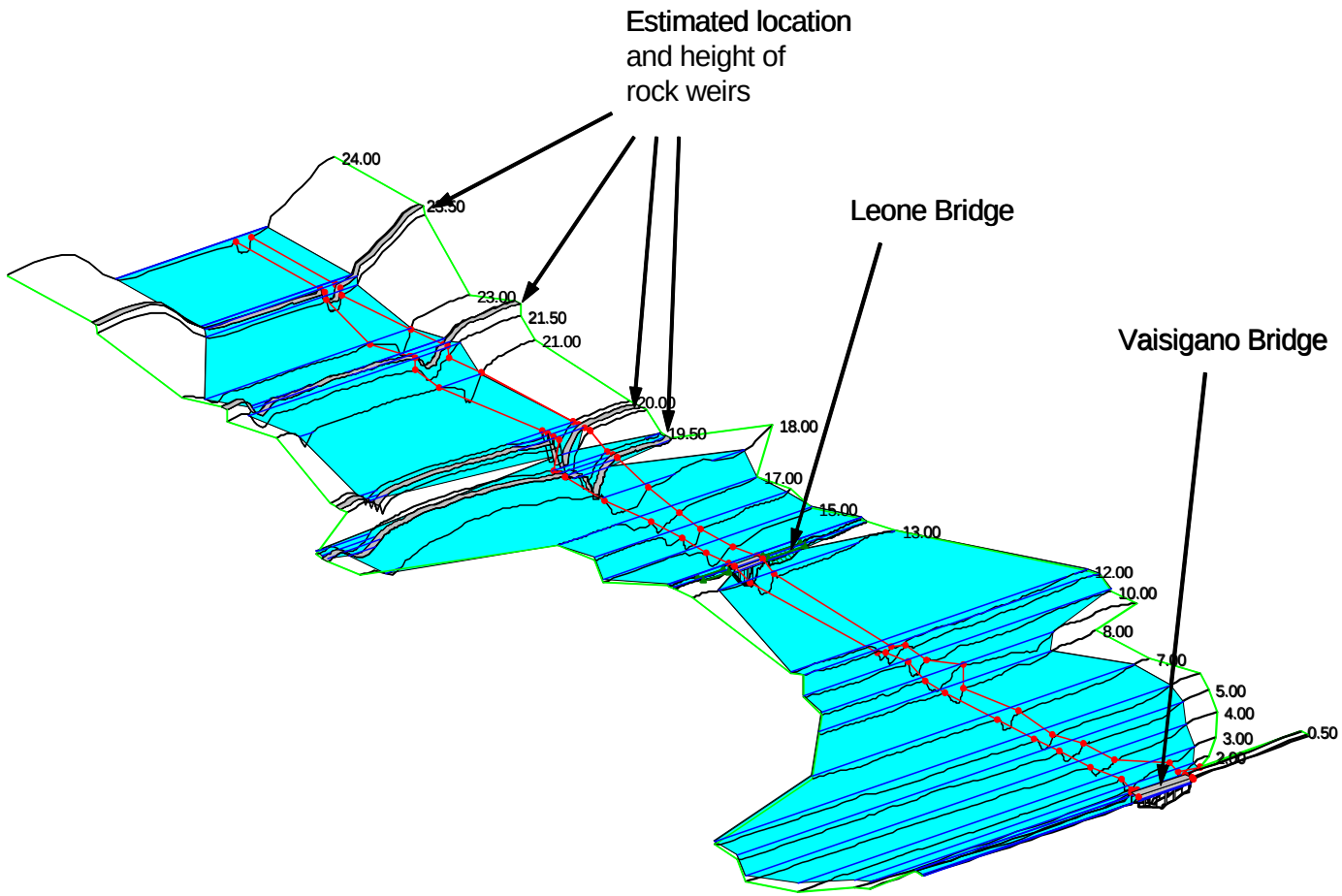


Flood Extent 2001



after S. Yeo 2001

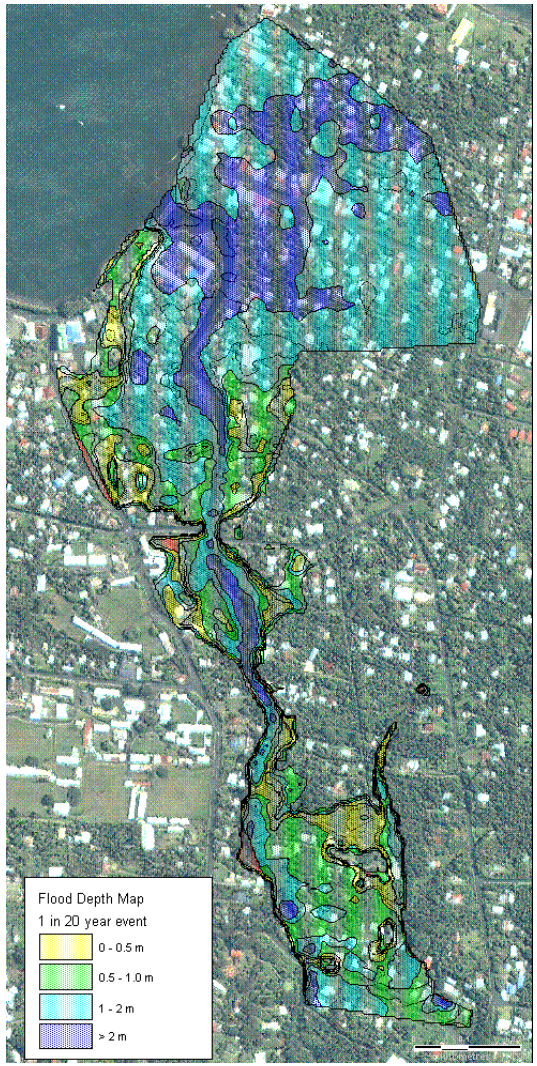
1D HEC-RAS Model



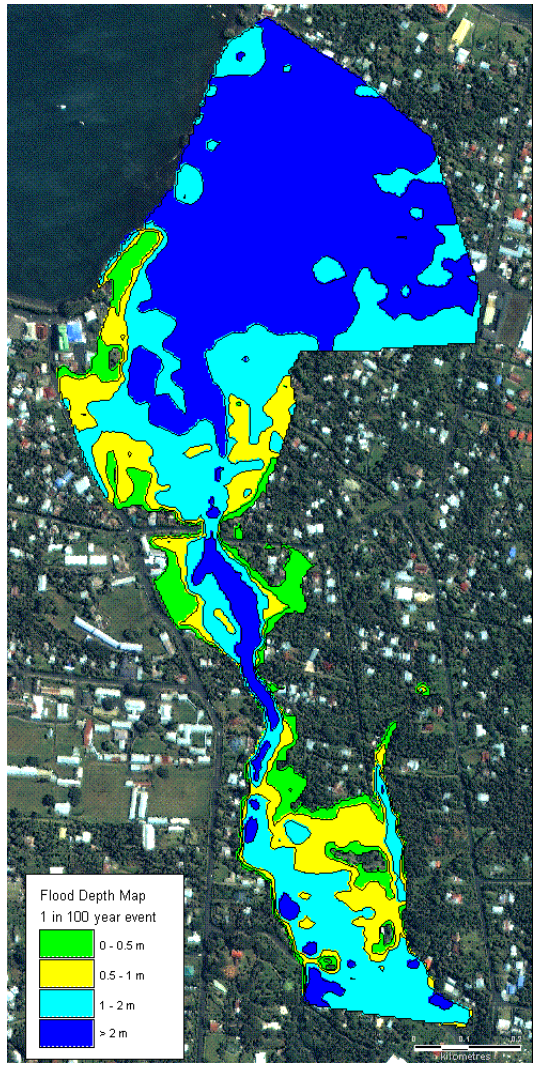
Critical River Sections

Flood Depth Maps

1 in 20 years



1 in 100 years

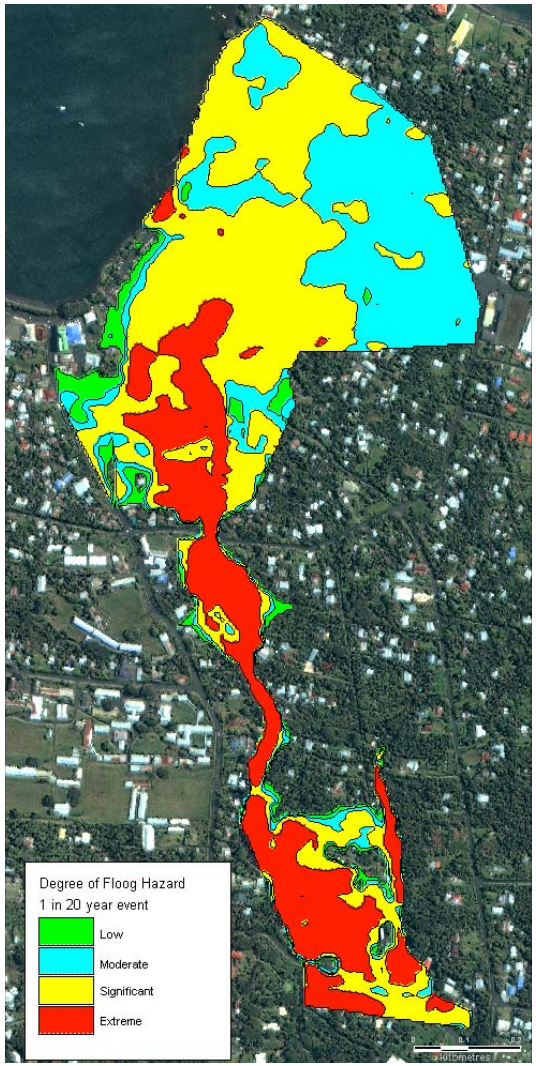


Assessing Flood Hazard

Floodwater depth (m) x water velocity (m/s) (m^2/s)	Degree of hazard	Description
Less than 0.75	Low	Caution Flood zone with shallow flowing water or deep standing water
0.75 to 1.25	Moderate	Dangerous for some (i.e. children) Danger: Flood zone with deep or fast flowing water
1.25 to 2.5	Significant	Dangerous for most people Danger: Flood zone with deep fast flowing water
Greater than 2.5	Extreme	Dangerous for all Extreme danger: Flood zone with deep fast flowing water

Flood Hazard Maps

1 in 20 years



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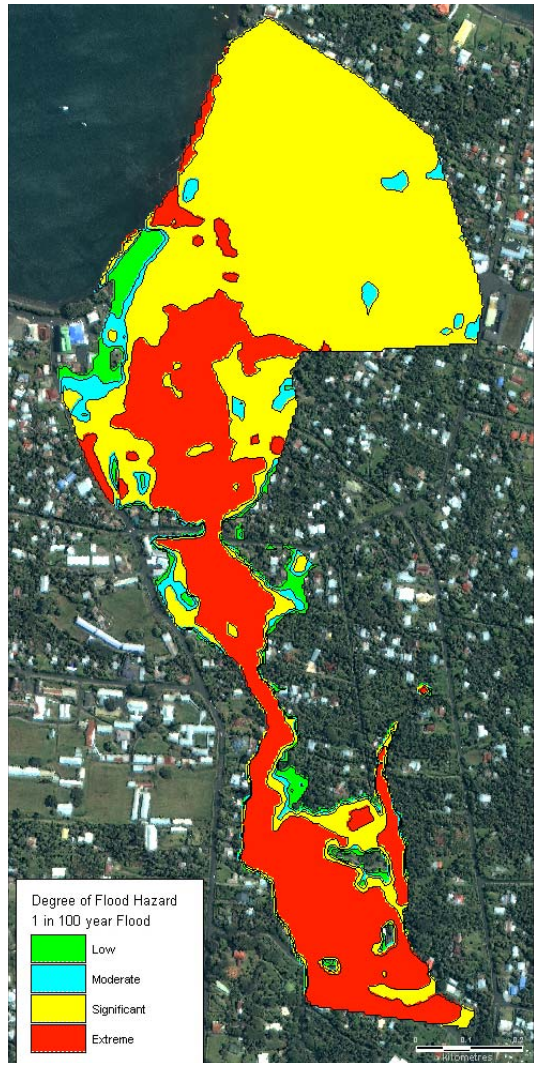
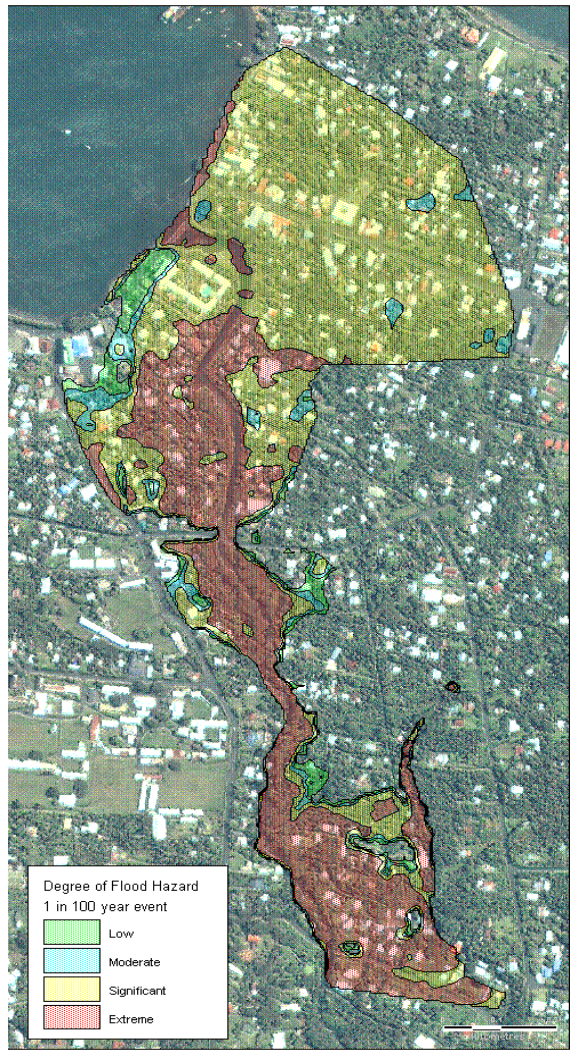


Assessing Flood Risks

- Estimate impacts to people and infrastructure

Return period	People @ risk	Buildings @ risk
1 in 2	1139	244
1 in 5	1382	296
1 in 20	1536	329
1 in 50	1596	342
1 in 100	1634	350

- Benefit-Cost Analysis

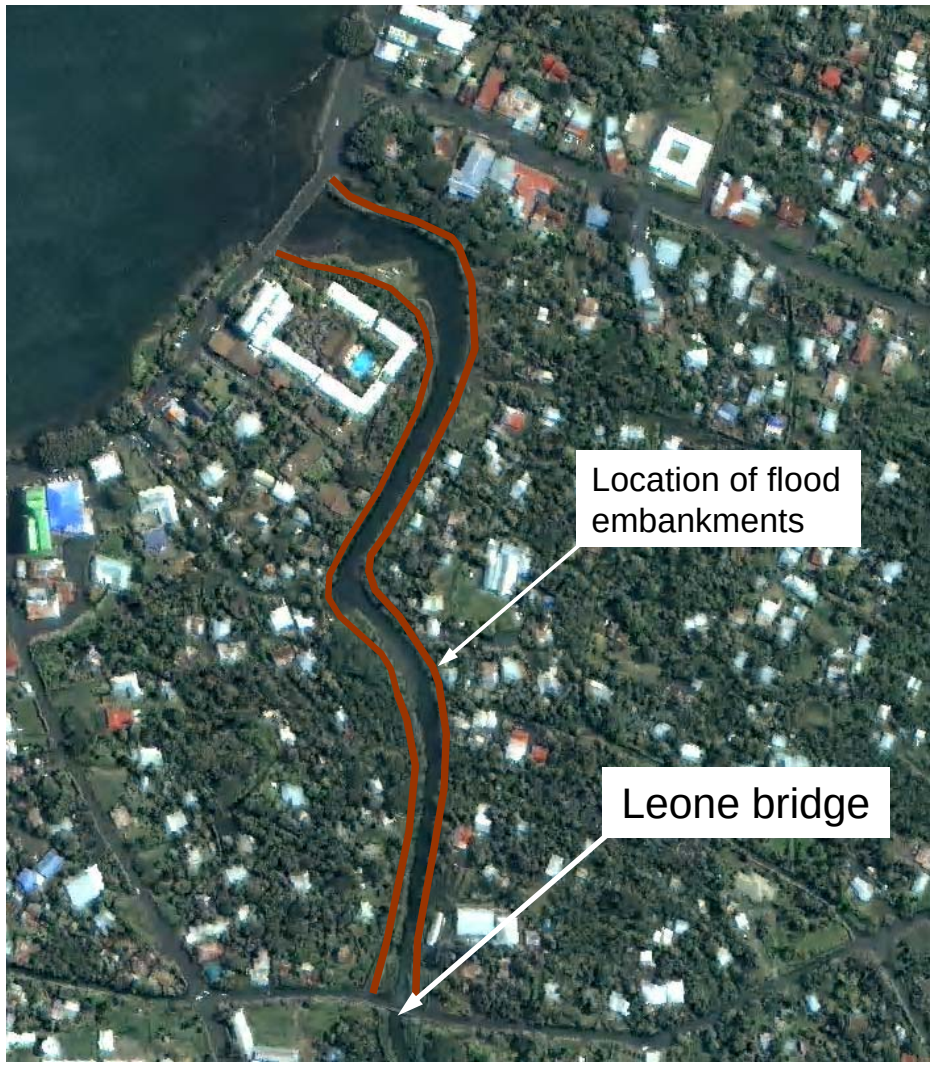


Assessing Mitigation Options

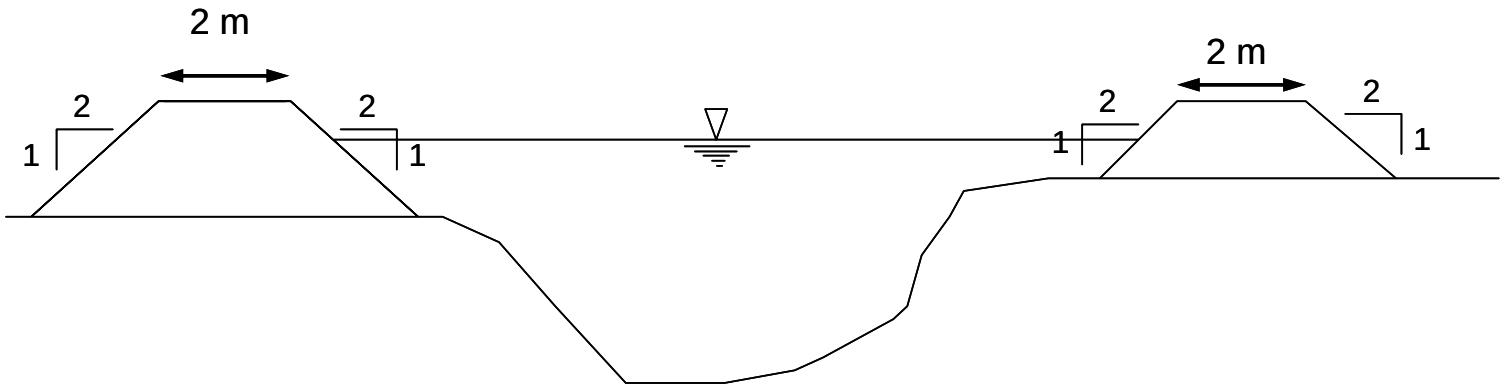
- **Structural :**
  - Flood walls and embankments.
  - By-pass channel.
  - Upstream flood storage.
  - Increasing channel conveyance.
  - Flood proofing of houses
  - Improving channel maintenance.
  - Pumping.

- **Non-Structural**
  - Floodplain zoning & Development control
  - Flood forecasting and warning
  - Flood insurance
  - Flood preparedness and response plans
  - Public Awareness
  - Land use change

Flood walls

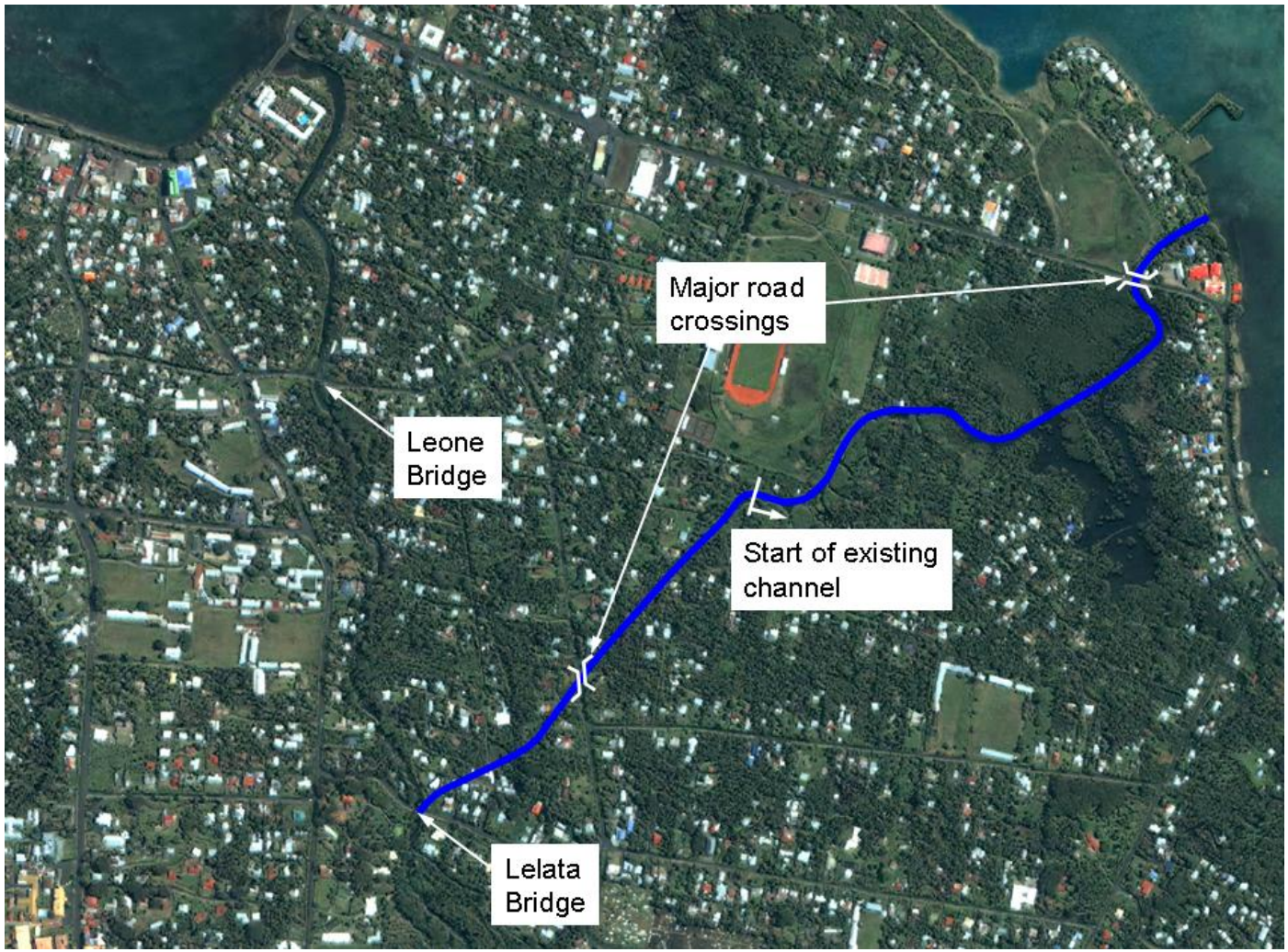


Flood embankments or walls

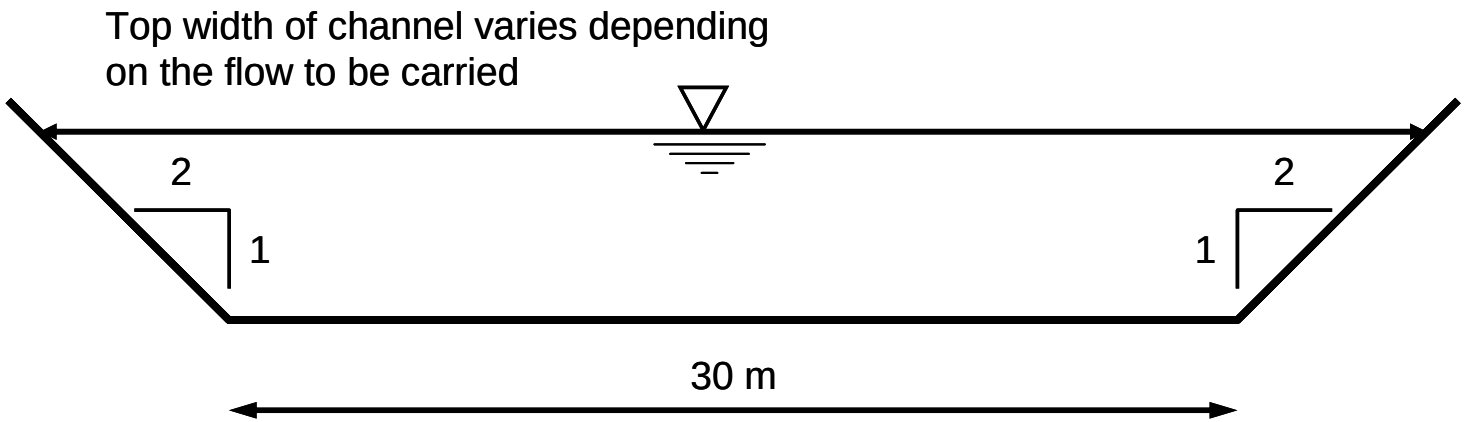


Return period (years)	Average height of the embankment (m)	
	Left bank	Right bank
1 in 2	0.96	0.61
1 in 5	1.72	1.35
1 in 20	2.54	2.13
1 in 50	2.83	2.40
1 in 100	3.24	2.81

Diversion channel



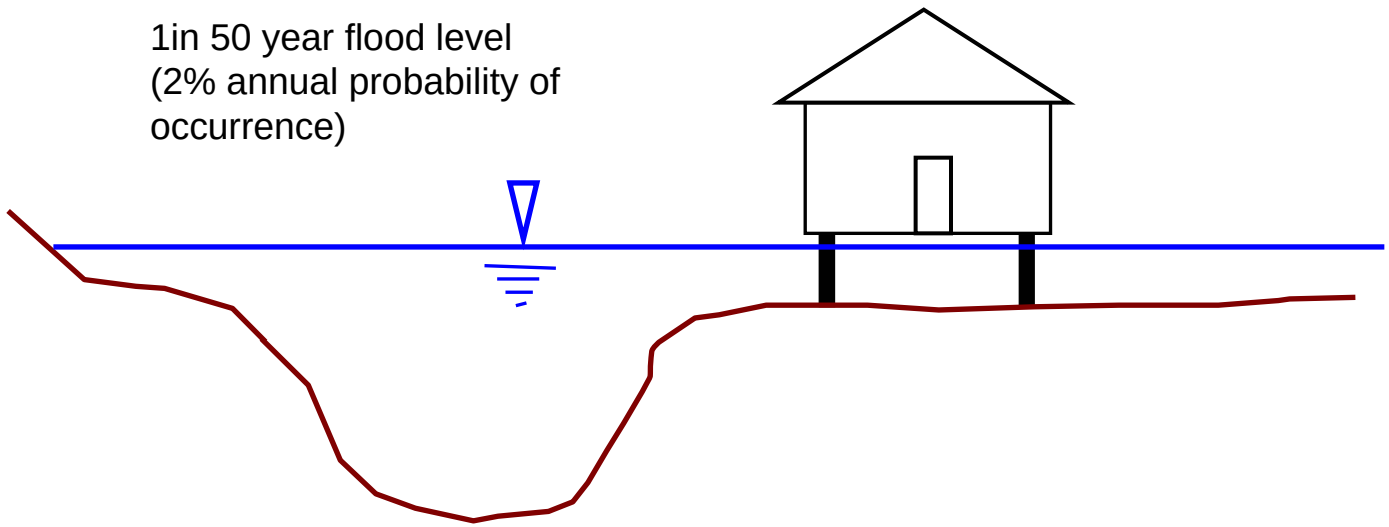
Diversion channel 2



Return period (years)	Capacity of the channel (m^3/s)	Depth of channel (m)	Top width of channel (m)
1 in 2	74	0.9	33.6
1 in 5	183	2.0	38.0
1 in 20	318	2.1	38.4
1 in 50	370	2.4	39.6
1 in 100	450	2.7	40.8

Flood proofing of buildings

- The design and construction of buildings with appropriate water-resistant materials.
- Raised floor levels above a flood with a specified return period (annual probability of occurrence).



Flood Forecasting

- Forecasting flood levels several hours in advance is difficult owing to nature of catchment
- Possible to issue flood warnings based on flash flood guidance estimates and scenarios.
- Requires access to a weather prediction model (Australian) that provides hourly rainfall estimates

Flood Warnings

- Establish a mechanism to warn communities in the lower Vaisigano River even if a flood occurs in the middle of the night
- Develop a series of staged flood warnings
- Establish a process (e.g. an advertising campaign in the media) to ensure that communities understand what each different warning means.

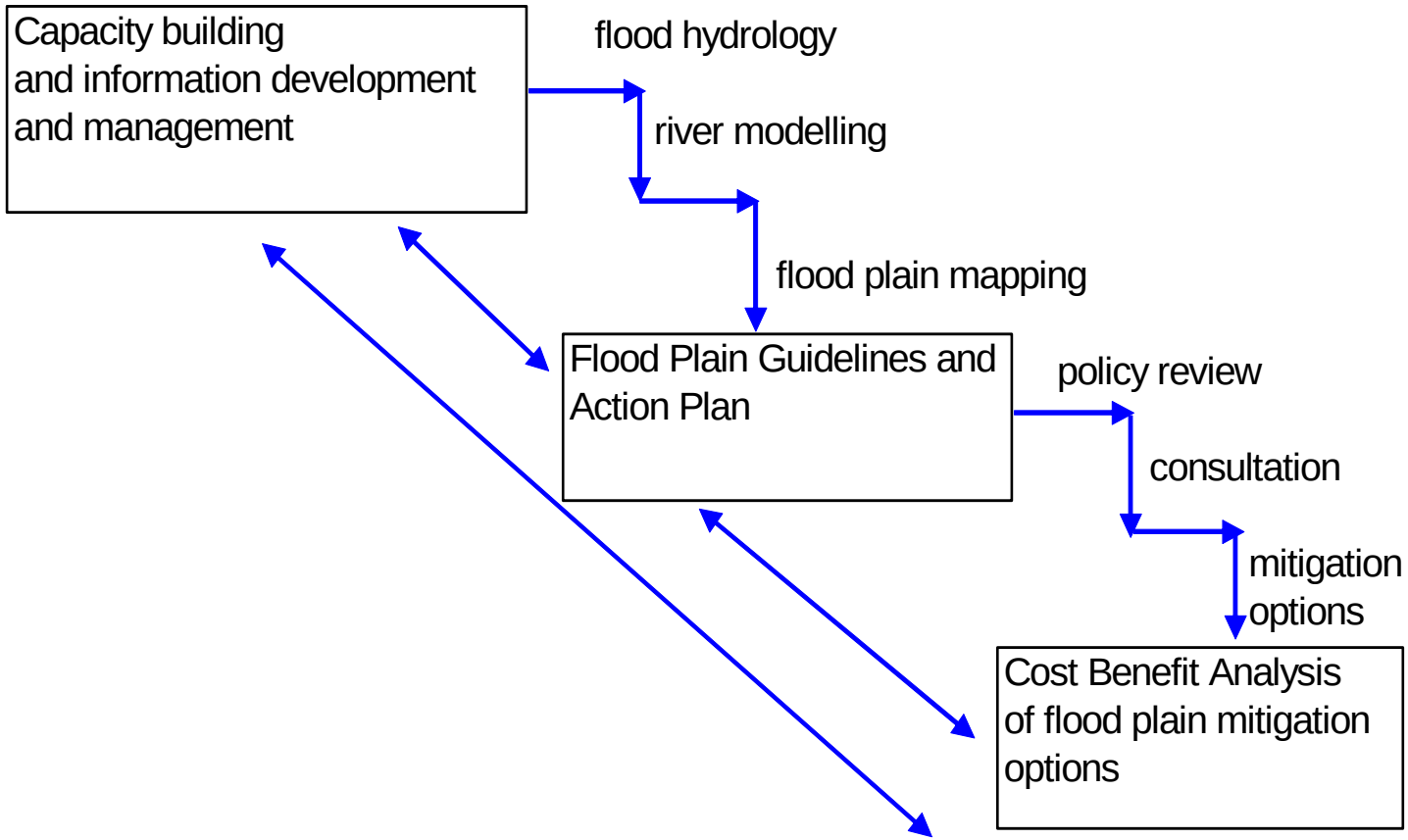
Conclusions - Mitigation Measures

- Pumping, Catchment Management and Channel Maintenance have only limited effects on flood flows in Samoa
- Reduce uncertainty in data (hydrological, topographical etc) for more accurate assessments
- Update models, maps and Action Plan as more accurate data becomes available

PART II

Policy

Recall the Process



Floodplain management guideline

- Responsible for land use planning and flood plain planning
- Development assessment and consent before a building permit could be issued by the Ministry of Works, Transport and Infrastructure (MWTI)

Development assessment

- Development control is concerned with whether or not developments should be allowed/constructed in areas that can flood and, where developments are permitted, the conditions or controls attached to the development of defined areas.

Such controls are aimed at, for example:

- reducing the risk of buildings and other assets being flooded.
- reducing the resulting damage when above floor flooding occurs.
- avoiding increases in flood risk elsewhere.

Con't..

Typical development control requirements may include for example:

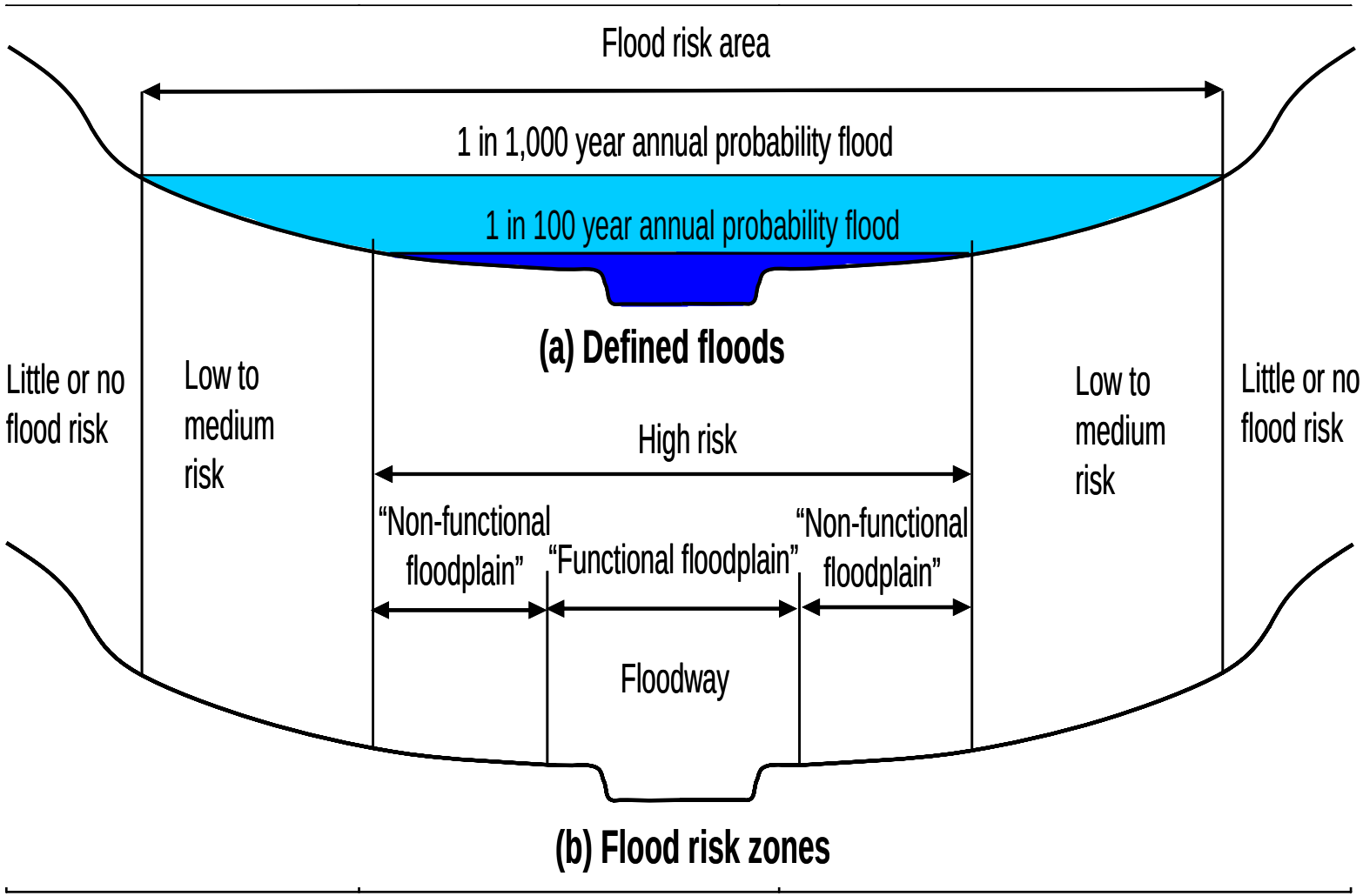
- identification of areas where building may and may not be permitted.
- minimum floor levels.

The safety of people during a flood event is important in the development of areas that are at risk from flooding. Evacuation can be very hazardous if safe evacuation routes are available

Floodplain Management Guidelines

- Provide generic background into management of floodplains
- Planning Tool
  - Provide guidance/checklist for development assessment in floodplains according to level of risk
  - Guide for integrating flood risk assessment into EIA process

Defined floods and flood risk zones



1. Examples of landuse on flood zones

- Notes:
- (1) Should be operational in a flood. Compensation works needed to avoid an increase in flood risk elsewhere.
- (2) Assuming appropriate flood defenses are provided.
- (3) Limited developments permitted in certain circumstances.
- (4) Not main school buildings and access routes.

Action Plan

- Provides Background of Flood Mitigation Options (Vaisigano/Samoa)
- Identifies 48 Actions for Integrated Flood Management, incl. responsible agencies and target dates
- Goals:
  1. Flood Risk Reduction
  2. Strengthen Flood Preparedness and Early Warning Systems
  3. Capacity Building in Flood Management
  4. Technological Information Management
  5. Sustainable Watershed Management
  6. Flood Governance

Purpose of Economic Analysis

- Ensures ‘efficient’ use of resources allocated to disaster management sector by implementing flood management measures with greatest ‘net’ benefits

- Advocacy tool- demonstrates the long-term savings that result from being pro-active by investing in flood management measures in the short-term

Flood management measures

- Priority flood management measures identified by stakeholders in March 2007:

- **Structural measures**
  Floodwalls/embankments
  By-pass/diversion channel

- **Non-structural measures**
  Improved flood forecasting system
  Development control- elevated floor heights

Damages Associated with Flooding

Flooding imposes significant costs on households and businesses in the lower Vaisigano:

Direct Damages

- Damage to houses
- Damage to household contents
- Damage to shops/offices
- Damage to business stock
- Damage to infrastructure (roads, power, water)
- Damage churches and schools

Indirect Damages

- Lost household income
- Household clean-up costs
- Business clean-up costs
- Lost revenues

Impact of Flooding

Sources of data

- Household and business surveys
- SOPAC flood maps
- Stage-damage curves

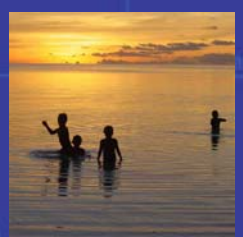
- Flood events
  - 1 in 5, 1 in 20, 1 in 50, 1 in 100
- Annual average damage estimated to be approximately WST$620,000 per year

Economic Pay-off from Investing in Selected Flood Management Measures

Flood measure	Best case
Floodwalls	0.64
Diversion channel	0.09
Improved forecasting system	1.92
Elevated floor heights:	
Existing homes	8.07
New homes	44.38

- E.g. Estimated for every tala invested in constructing homes with raised floor heights, a maximum of WST$44 is avoided in future flood damages

Conclusions and Recommendations



- Structural flood management options generally not cost-effective due to high construction and maintenance costs

- Improved flood forecasting system should be implemented, however this must be done in conjunction with improved warning systems and public awareness campaigns

- Economic pay-off from raised floor heights in new homes very high

- Economic analysis can assist with prioritizing which flood measures should be implemented and assist with leveraging funding for implementing the most cost-effective measures