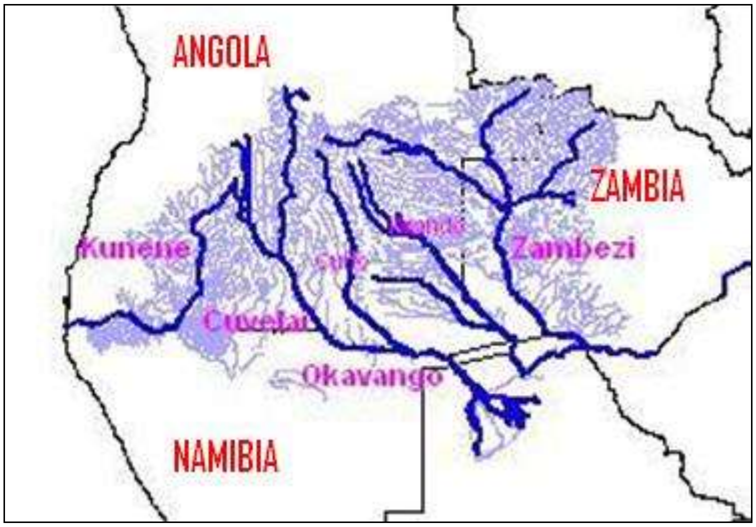
# Namibia: Flood mapping project
# Concept proposal

***Ministry of Agriculture, Water and Forestry***
***August 2010***

## Contents

## 1. Background

1. Namibia is a semi-arid to arid country with a seasonal and highly variable climate and it has always been subject to hydro-meteorological extremes, such as droughts and floods. In 2008 and 2009, torrential rains occurred in the northern areas of the country and in the headwaters of the major rivers draining from the neighbouring countries (Angola and Zambia) to the north to these areas, resulting in exceptionally high floods.




2. In the Cuvelai Basin, in the central north, the 2009 floods exceeded those that had occurred in 2008, which had already been evaluated as the highest in living memory. In the northeast, the floods in the Okavango, Kwando and Zambezi rivers were the highest on record for 40 years or more. Depressions that had been considered fossil remainders of ancient channels and lakes experienced flows never expected to be active again.

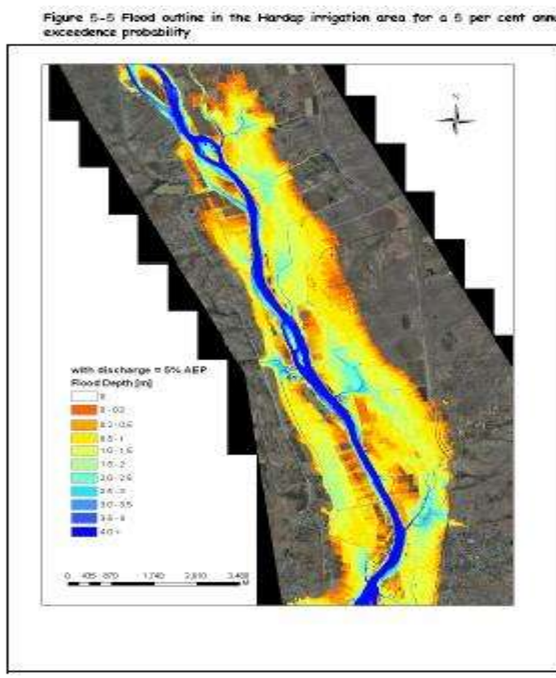
3. These very large floods devastated northern Namibia, where more than half of Namibia's population lives, for prolonged periods, causing losses of life, displacement of people, destruction of infrastructure, disruption of agricultural and of other economic activities and increased waterborne diseases.

4. The sudden occurrence and unexpected repetition at short interval of these events, with a new very high flood developing in the Zambezi River in 2010, may be associated with climate variability and change impacts, and it is therefore possible that the frequency and magnitude of high floods will increase in years to come.

5. The Post Disaster Needs Assessment (PDNA) carried out by the Namibian Government with support from the international community estimated the total direct damage at 136.4 million US$ and the indirect losses at 78.2 million US$$. The full reconstruction and recovery cost would be 622.1 million US$. The conclusions and recommendations of the study emphasized that recovery, risk reduction and better preparedness and response for future flood disasters should also include accurate and adequate flood risk mapping of the concerned areas.

## 2. Flood Risk Mapping Concepts

6. In its strict technical sense, flood risk mapping could be defined as the production of flood 'hazard' maps, i.e. physical terrain maps showing the contoured areas that show the inundation limits for floods of specified magnitudes and/or frequencies. More detailed flood hazard mapping would show not only the extent of the inundated areas, but also inundation durations, maximum flow depths, maximum flow velocities and preferential flow paths, overlaid on physical terrain and soil maps to better indicate expected inundation patterns and even erosion risks.




***Example of flood hazard mapping for Mariental (from hydraulic analysis)***

7. For sensible application, however, flood risk mapping should also include flood vulnerability maps showing the spatial distribution of population, economic activities and infrastructure at risk. Risk is then often defined as hazard times exposure.

8. Floodmaps or flood risk maps should have overlays showing combinations of hazard and vulnerability factors.

9. Participatory flood risk mapping should then be applied for consensus decision making and involvement of communities and stakeholders on reconstruction and further development decisions in the affected areas. This process will also ensure that flood risk mapping gives the right information in the right presentation that is understood and used by those affected.


***Example of flood risk mapping for Rundu (from satellite images)***

10. The application of flood risk mapping is the most obvious for planning purposes, town planning in urban areas, land use planning in rural areas, planning of infrastructure like roads and water carriers, but it is equally relevant in all phases of disaster cycle management, preparedness, early warning, response and recovery. It should in particular be included in the hydrological early warning and forecasting systems that emphasize flow characteristics like water levels and flow rates at specific sites without reference to aerial extent of expected inundations. For Namibian conditions, already the existing warning systems have been good in producing forecasts for timing and height of floods in for instance Zambezi and Orange rivers. The impact on the ground, however, can only be described in qualitative terms, leaving response decisions open.

As an example the hydrological forecast for the presently (end-Feb 2010) developing flood in the Zambezi River is that the level in Namibia (Katima Mulilo) will reach 7 m by mid-March, in many ways an excellent and timely warning. Yet there is no precise forecast for expected impact and required response. The best available indication given is that "the inundation will be similar to 2007, lower than in 2008 and lower than in 2009", and accurate flood hazard and vulnerability mapping would be required for effective response. The same occurred for the flood in the Lower Orange River earlier in 2010, when timing and maximum flood levels were forecasted with an accuracy better than one day and 10 cm respectively more than a week before but when no good indication could be given of the areas that would be inundated, except by reference to historic lower and higher flood occurrences.

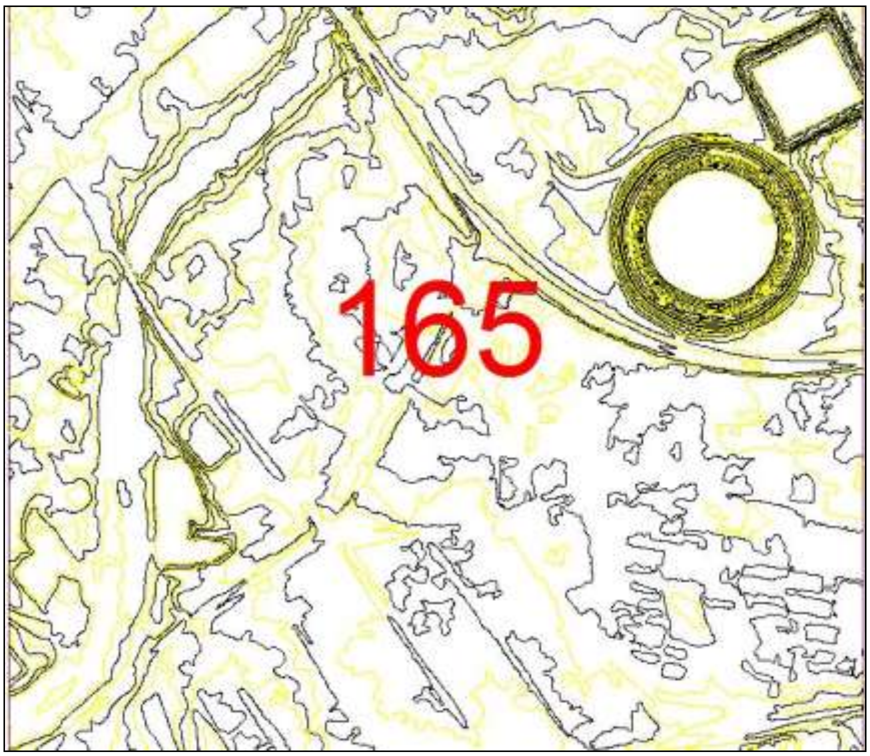
11. Flood risk mapping is also required for vulnerability analysis and awareness creation, and for operational management during floods, determining access and escape routes and areas for evacuation and safe relocation.

12. Ultimately, the same information used for flood risk mapping is required for Investigation of structural flood protection and mitigation measures, e.g. dykes, diversion channels, flood reservoirs

## 3. Flood Risk Mapping Approach

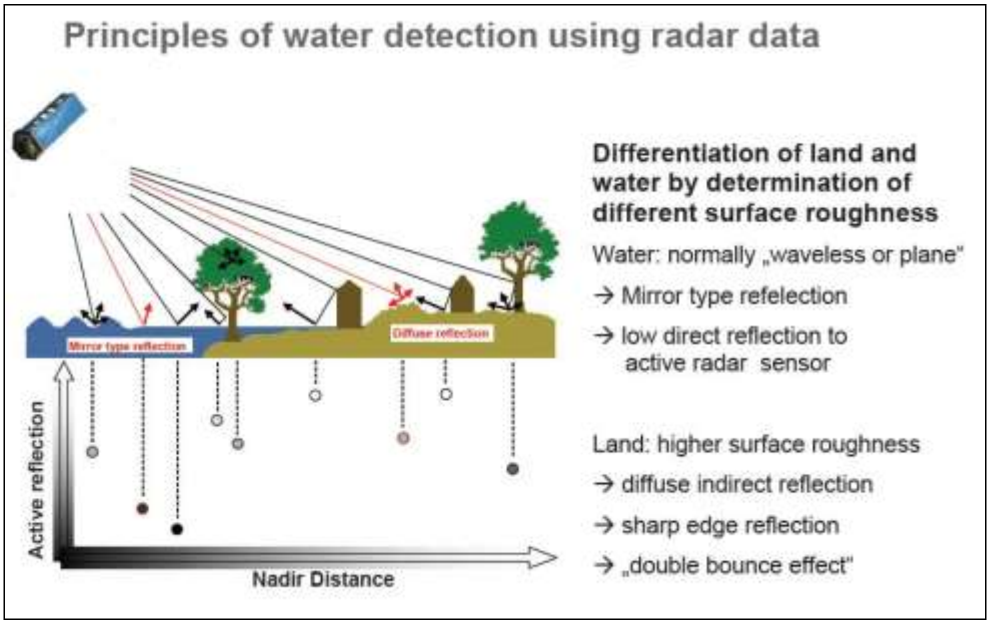
13. The analysis and output tool for the final flood risk mapping is:

a. A GIS structured database, with spatial datasets and mapping and analysis tools.
b. Hazard mapping requires:
c. Analysis of hydrological information to determine flood magnitudes and frequencies.
d. Terrain topographical data (survey, digitals terrain models - DTM) as input for terrain floodmapping

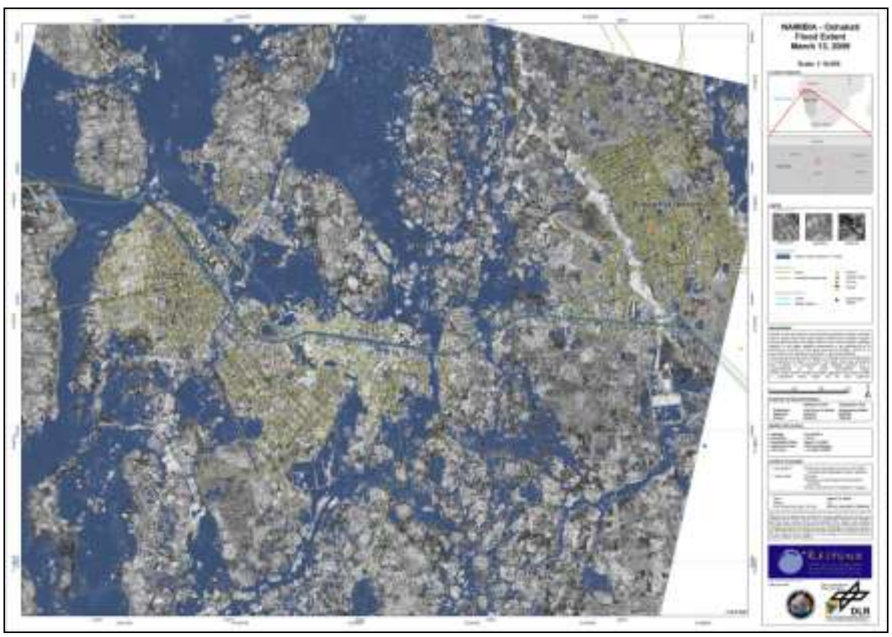



***Example of lidar survey for Oshakati***

e. Hydraulic analysis to determine corresponding theoretical floodlevels and flood extents
f. Empirical validation from terrain and remote sensing observations during floods, using floodmarks, aerial photography and increasingly remote sensing scenes from satellites, using radar sensors (to avoid the cloud interference that hampers the application of normal aerial photography or optical satellite images), with which good experiences were obtained during the 2008 and 2009 floods




***Principle of floodmapping using satellite radar sensors***



***Example of radar sensor floodmap for Oshakati***

14. Exposure maps require relevant 'geo-data':
    g. Spatial information on population distribution, settlement patterns, public infrastructure (roads, schools , health centers) and industries – "geodata"
15. An essential component to achieve participatory floodmapping is:
    h. Participation, understanding and consensus of stakeholders

16. All information needs then to be brought together, analyzed and made available in an understandable format:

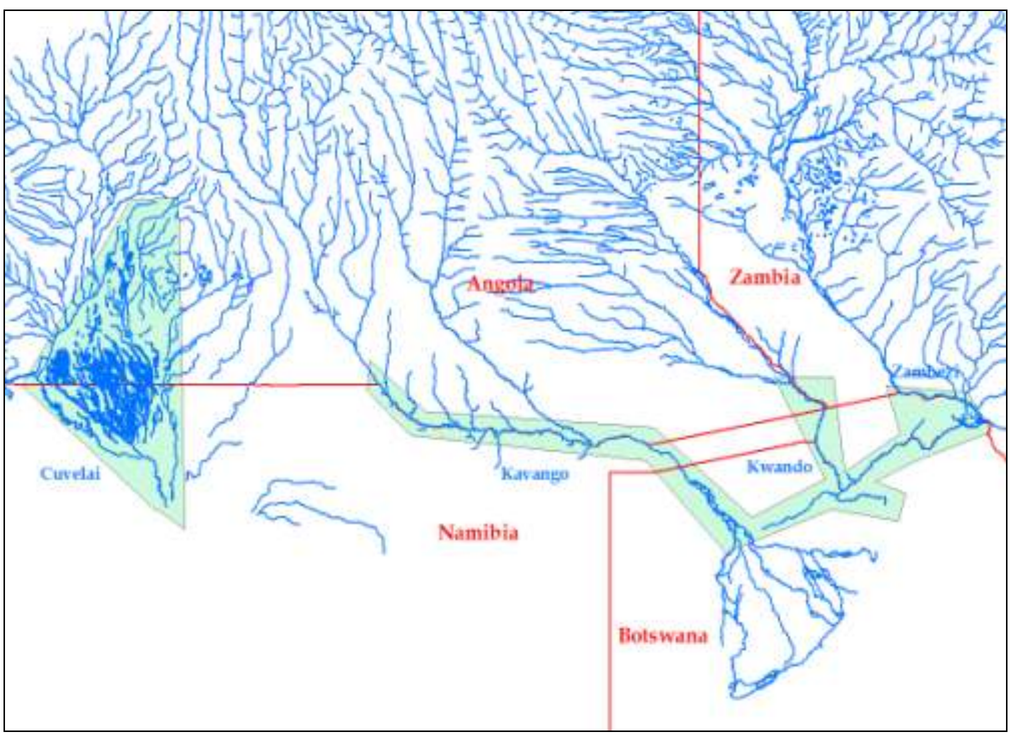
i. Database with GIS digital layers ("Geo-database") with flood hazard characteristics and vulnerability geodata, and with analysis reports and flood risk mapping

17. For the purpose of an integrated approach, three additional components should be included:

j. A flood model for the catchment that is required for both real-time early warning and forecasting and for the evaluation of climate change effects
k. An evaluation of climate variability and change effects on the expected frequencies and magnitudes of floods in future
l. A reconnaissance assessment of possible structural flood protection and mitigation measures to be proposed for detailed investigation.

## 4. Areas at Flood-risk in Namibia

18. Flood risk mapping may also be required in all urban areas and in all development zones along rivers throughout Namibia, but this would expand the project beyond practical feasibility and it should rather be covered as part of specific planning projects. The possible targeted areas for this project should be these that were affected by the flood disaster in 2009: Central north (Cuvelai) and North east (Zambezi-Chobe, Kwando-Linyanti and Kavango)




19. Practical issues, however, exclude two areas for the following reasons:

- *Kavango:* This is a 350 km long strip, for most of which the Kavango River is the border with Angola. Floodmapping should be done as a bi-national project, as it is not feasible to collect the necessary information only on one side of the border (aerial survey, ground verification), and as a one-sided approach would hurt national sensitivities in the other country. Funding might also be more easily available under one of the many projects that cooperating partners are supporting for the Okavango River Basin. A project proposal will therefore be submitted to the Okavango River Basin Commission for endorsement to be forwarded for such support. Such project would then also emphasize capacity building and extend into the adjacent river reaches upstream and downstream in Angola and Botswana respectively.

- *Kwando-Linyanti:* The hydrological régime of this wetland area is characterized by prolonged wet and dry cycles. The generally high floods since 2000 and in particular the exceptional floods in the Kwando River in 2009, with additional floodwaters pushing in from both Zambezi River and Kavango River through the Chobe and Selinda channels respectively, has turned the area into a semi-permanent swamp, for an indefinite time to come, with no realistic possibility for aerial surveys that would determine terrain levels or ground access for verification. The Kwando-Linyanti strip in fact is the border with Botswana for most of its length and the situation is similar as for the Kavango that floodmapping should be done in cooperation with the other country.

## 5. Project Organization

20. The project execution would be supervised by a Project Steering Committee that is responsible for the implementation of the project, with the following functions:

(i) Set up its own working procedures rules.
(ii) Establish and when necessary review the work programme.
(iii) Supervise the execution of the project activities and the allocation of funds.
(iv) Supervise the selection of the teams and experts to carry out these activities, including selection and appointment of consultants and contractors.
(v) Give guidance to these teams and experts and make arrangements to facilitate their assignments.
(vi) Monitor the progress of activities, by means of documentation to be provided by the teams and experts and by scheduled and ad-hoc meetings.
(vii) Monitor and control spending of external funds, including payments to consultants and contractors, and solicit additional funds if and when required.
(viii) Ensure coordination and cooperation with other projects and activities in the area of flood management.
(ix) Ensure the compilation of regular progress reports, both on activities and financial matters.
(x) Ensure the performance of any other tasks required to achieve the project objective.

21. The Steering Committee will consist of nominated members of the following organizations:

(i) Hydrology Division in Ministry of Agriculture, Water and Forestry
(ii) National Planning Commission in Office of the President
(iii) Directorate of Disaster Management in the Office of the Prime Minister

(iv) Ministry of Works and Transport/Roads Authority
(v) Ministry of Regional and Local Government and Housing and Rural Development
(vi) Cooperating partner(s) (World Bank ,USAID)

22. Any number of other persons, as nominated by one of the organizations or by the Committee, may be co-opted to take part in the activities of the Project Steering Committee, including meetings.

23. The Namibian Ministry of Agriculture, Water and Forestry will be the implementing organization for the project, with the Hydrology Division in this Ministry responsible for operational activities, either by own activities or by direct operational supervision.

## 6. Description of Activities

24. In the following, it should be noted that:

i. Durations for activities include making contractual arrangements, delivery times, mobilization etc, and not effective time utilization for physical implementation.
ii. Project staff refers to detached Namibian staff of Hydrology Division
iii. In kind contributions by making staff and logistics available is not explicitly costed.
iv. For every activity, capacity building public awareness raising and information sharing should be included.

***Activity 1: GIS structured database***

25. The objective is to set up a geographical database with spatial data sets and mapping and analysis tools. It is envisaged that the GIS database of the Bureau of Statistics in the National Planning Commission will be the basic system. Project staff is acquainted with available ArcGIS basic modules. The main activities will be:

i. Familiarization of project staff with this system.
ii. Selection and acquisition of required software modules and training of project staff.
iii. Transfer of selected datasets from NPC.

26. The financial requirement is estimated at N$ 400,000 for software and training. No inputs from other activities are required. The expected duration of this activity is three months, but it can be executed in parallel with other activities. The output is required for most other activities in particular activity 8. The deliverable is an operational GIS structured database with basic data sets, compatible with the NPC system and capable of handling the further tasks.

***Activity 2: Hydrological analysis***

27. The objective is to determine flood frequencies and magnitudes for the two project areas. Flood magnitude is meant to comprise areal and temporal distribution characteristics, with spatially distributed flood hydrographs so that unsteady 2-D hydraulic modeling can be applied, in particular where flood modeling through flood plains is applicable. This will be fairly straightforward for the Zambezi-Chobe area, where reliable long records are available. For the Cuvelai area, such records are virtually non-existant, and modeling might be required. For both areas, timing of the floods is relevant

for seasonal agricultural activities. Also for both areas, there are no major reservoirs operated upstream and real-time flood control needs not to be considered. The main activities will be:

i. Collection and quality control of hydrological records
ii. Statistical analysis or records
iii. Comparison with deterministic flood determination methods
iv. Comparison with empirical flood determination methods
v. Final evaluation
vi. Report compilation

28. This is a desk study that can be handled by project staff, and there is no financial requirement. No inputs from other activities are required. The expected duration of this activity is two months. The output is required for activity 4 and is also related to activity 10. The deliverable is a report with proposed flood frequencies and magnitudes for the project areas.

***Activity 3: Terrain topographical data***

29. The objective is to make available the Digital Terrain Model (DTM) for the hydraulic studies. This will be the project component requiring the bulk of the financial resources. Because of the flat terrain and the complex drainage system, available topographic information is inadequate and a survey with accurate elevation will have to be performed over large areas. The DTM will also be used to generate the geometric cross-sections of channels and floodplains and the longitudinal sections of the channels for the hydraulic calculations. This will avoid the alternative of ground surveys but also require a fine grid resolution and good vertical accuracy. For the Cuvelai this will be a fairly well delineated polygon. For the Zambezi, a combination of areas will have to be selected to avoid surveying large zones that are inundated each year. From experience with similar surveys for smaller areas, the available IT infrastructure will have to be upgraded. The main activities will be:

i. Elaboration of technical specifications for terrain survey (most probably lidar aerial survey with ground controls), DTM
ii. Specifications for required hardware, software and training
iii. Finalization of areas to be surveyed (Cuvelai, Caprivi)
iv. Contractual arrangements for terrain survey
v. Selection, acquisition, installation and training for hardware and software
vi. Execution of terrain survey
vii. Processing of terrain survey results
viii. Generation of DTM
ix. Survey and DTM report

30. The survey will most probably be a lidar aerial survey, for which specialized staff and equipment are required. Such survey also requires extensive ground control. Because of the high cost, alternatives have been considered, but so far on suitable DEMs with adequate grid resolution elevation accuracy have been identified. The public-domain 90 m and 30 m available from internet are not suitable. From previous similar contracts, and from tender prices, the following cost estimates for lidar aerial survey are made:

| | | |
|---|---|---|
| Cuvelai: | mobilization: | N$ 200,000 |
| | Survey, including processing and DTM: | |
| | *7,500 km² @ N$ 1,200* | N$ 9,000,000 |
| | Ground control: | N$ 350,000 |
| Zambezi: | mobilization: | N$ 200,000 |
| | Survey, including processing and DTM: | |
| | *2,000 km² @ N$ 1,500* | N$ 3,000,000 |
| | Ground control: | N$ 200,000 |
| IT hardware, software, training: | | N$ 150,000 |
| **Total:** | | **N$ 13,100,000** |

31. No inputs from other activities are required, except that some requirements from activity 5 should be incorporated in the survey work. The expected duration of this activity is six months. An important time constraint is that the aerial survey should be carried out in the dry season, between May and August to avoid delays and cost implications because of cloud interference. The output is required for activity 4. The deliverables are the survey computer files and the DTM for the project areas.

***Activity 4: Hydraulic analysis***

32. The objective is to determine the theoretical floodlevels and flood extents for hazard mapping. Geometric cross-sections and longitudinal profiles of the channels will be derived from the DTM. This project component will require more than the usual one-dimensional hydraulic calculations for channel systems with floodplains. For the Cuvelai, the drainage system is a looped network with floodplains in between. For the Zambezi, the situation is two-dimensional with possible bi-directional flow, and the gradient of the floodplain is away from the main channel. Project staff has limited acquaintance with available basic 1-D MIKE11 modules. It is foreseen that additional extensions and training will be required for full 2-D unsteady hydraulics for the modeling of flood movements through floodplains. The main activities will be:

i. Selection, acquisition, installation and training for hardware and software
ii. Extracting data from DTM and setting up data files, including creation of drainage network
iii. Hydraulic calculations for floodlevels
iv. Hazard mapping
v. Report

33. External expertise will be preferable for starting this activity, and the cost estimates are as follows:

| | |
|---|---|
| Software with installation and training: | N$ 150,000 |
| Expert input (one month in total): | N$ 100,000 |
| *TOTAL:* | *N$ 250,000* |

34. Activities 2 and 3 provide inputs for this activity. The expected duration is four months. The outputs are required for activities 5 and 8.The deliverables are the report with the calculations results and the digital hazard mapping.

***Activity 5: Empirical validation of theoretical hazard maps***

35. The objective is to verify and improve hazard mapping from terrain and remote sensing information during floods. During the 2008 and 2009 floods, the UN space charter and other support provided extensive floodmapping for both areas. Ground verification at the time confirmed this information to be accurate, and more information will be searched for in remote sensing archives. Project staff has limited acquaintance with available remote sensing processing software (Erdas), and additional modules and training will be required. Local knowledge on historic floodlevels and extents will also be sought. And there may be especially good awareness of the flooding in 2009 (or in 2010 if occurring again). The main activities are:

i. Collation of terrain information (historic floodmarks, local observations)
ii. Selection, acquisition, installation and training for hardware and software
iii. Collation and interpretation of satellite remote sensing scenes
iv. Validation and revision of theoretical hazard mapping
v. Report

36. The cost estimate for this activity is N$ 100,000 for software with installation and training. This project activity will be supported by other on-going projects (UNOOSA sensor web, TIGER) with international partners (NASA, DLR, USRI, ITC, EU/JRC). Activity 4 is the starting input for this activity. The expected duration is four months, but it can start in concurrence. Some requirements are to be incorporated in activity 3. The output will be useful for activity 7 and is required for activity 8. The deliverables are the report with the validation results and the digital hazard mapping.

***Activity 6: Vulnerability information and mapping***

37. The objective is to produce mapping with available economic values for housing, agricultural lands and transport infrastructure (roads and bridges). For each category, the analysis will provide estimation of replacement costs per unit (km of roads or nature of habitat) or lost production per unit area for different type of crops and livestock. The analysis will use a percentage damage function for different water depth. It is envisaged that this activity will cover the existing data sets available at NPC or collected during the 2008 and 2009 disasters, but that no new ground surveys will be carried out, because of time and resources constraints. Instead, the study should identify missing information and give very precise guidelines for the collection of such information as part of the next census planned to take place in 2011, which has a component for the development of a national infrastructure GIS database. There is limited expertise in Namibia for this approach, and expertise should be brought in to initiate and supervise the activity and to train project staff. The main activities are:

i. Definition of relevant information: population distribution, settlement patterns, public infrastructure, private development and industries
ii. Training of project staff
iii. Data collation

iv. Transfer to mapping
v. Report

38. The main cost for this activity is the input of the external expert estimated at N$ 200,000 (two months). No inputs from other activities are required, except for some indication of the flood-risk areas. The expected duration of this activity is three months. The output is required for activities 7 and 8. The deliverables are the report with the collated exposure information and vulnerability analysis and the digital exposure/vulnerability mapping.

***Activity 7: Stakeholders' involvement***

39. The objective is to achieve participation, understanding and consensus of stakeholders regarding acceptable risk and utilization of flood risk mapping. This is a strong recommendation in the PDNA report, but limited expertise is available in Namibia. The intention is to train Namibian project staff, both with community mobilization and technical background, and to have workshops/meetings in the flood-risk areas, first at community level and then at regional level. It will be attempted to combine the exercise with other events, like basin management meetings et alia. The main activities are:

i. Preparation of materials
ii. Training of Namibian staff (community and technical)
iii. Workshops at local level
iv. Workshops at regional level (2, Cuvelai and Caprivi)
v. Report with findings and recommendations

40. The estimated costs for this activity are:

| | |
|---|---|
| *Expert services:* | *N$ 200,000 (two months)* |
| *Community mobilization expert:* | *N$ 100,000 (two moths)* |
| *Workshops:* | *N$ 300,000 (nominal)* |
| ***TOTAL:*** | ***N$ 600,000*** |

41. Inputs from activities 4, 5 and 6 are required. Inputs from activities 10 and 11 may be useful. The expected duration of this activity is three months. The output is required for activity 8. The deliverable is the activity report.

***Activity 8: Finalized database and mapping and dissemination***

42. The objective is to finalize the database with GIS digital layers with flood hazard characteristics and vulnerability data, and with the resulting flood risk mapping, and to disseminate the products (maps). This will be the rounding off of all previous activities. The first is a desk activity with no requirement for financial resources. For the dissemination, public meetings will be used, and the estimated cost is N$ 100,000. All activities 1 to 7 provide inputs. The expected duration is three months. The outputs are related to activities 9 and 10. The deliverables are the finalized database and the mapping.

***Activity 9: Flood model***

43. The objective is to set up a hydrological model that will correlate rainfall and catchment conditions for real-time forecasting of floods and for evaluation of climate variability and change effects. The selection of such flood model will mainly consider the proven suitability for similar areas and the availability of data. Because of the limited catchment information, neural networks might be preferable. The main components will be rainfall measured on ground and estimated from remote sensing, rainfall forecasts, soil moisture and catchment saturation, surface runoff routing, upstream riverflow gauges and hydraulic routing. The purpose of the model is to forecast river levels and flows in the flood-risk areas and to link this information with floodmapping for flood response. The model should be flexible with parts of the upstream catchments well covered by riverflow gauges and other parts having only remote sensing rainfall estimates available. The model should also indicate gaps in the monitoring and early warning systems. It is thought that modeling software is freely available and that available IT hardware is adequate, but that some expert input is preferable for guidance of project staff with selection and calibration. Integration with early warning systems and floodmapping is envisaged as part of the UNOOSA sensorweb project. The model can then also be used to evaluate the effect of climate change. The main activities are:

i. Selection and installation with training of model
ii. Calibration of model
iii. Analysis of gaps in early warning systems
iv. Integration with early warning systems and floodmapping (not part of this project)
v. Report

44. The cost estimate for this activity is N$ 100,000 for expert input (one month). There are no input requirements from other activities. The expected duration is three months. The output relates to activity 8 and is required for activity 10. The deliverables are the report and the calibrated model.

***Activity 10: Climate variability and change evaluation***

45. The objective is to evaluate possible climate change effects on the expected frequencies and magnitude of floods. Hydrological analysis is based on the assumption that climate and hydrological regimes are stationary and that statistics of past records also represent the future. Yet, the apparent increase in frequency and magnitude of floods has been related to climate change, and then any planning of future events should take this in consideration. The evaluation will require expert input to evaluate historic trends and future scenarios for climate change, in particular for rainfall. This can then be used as input for the flood model to re-calculate frequency and magnitude statistics for future expected floods. The main activities are:

i. Study by consultant
ii. Re-run of flood model
iii. Report

46. It is not foreseen that Namibian staff will make meaningful inputs and the cost activity for this component will be the expert input for N$ 200,000 (two months).There may be some input from activity

2 and the model of activity 9 is required. The expected duration is three months. The output may be useful for activity 7. The deliverable is the report.

***Activity 11: Flood protection and mitigation assessment***

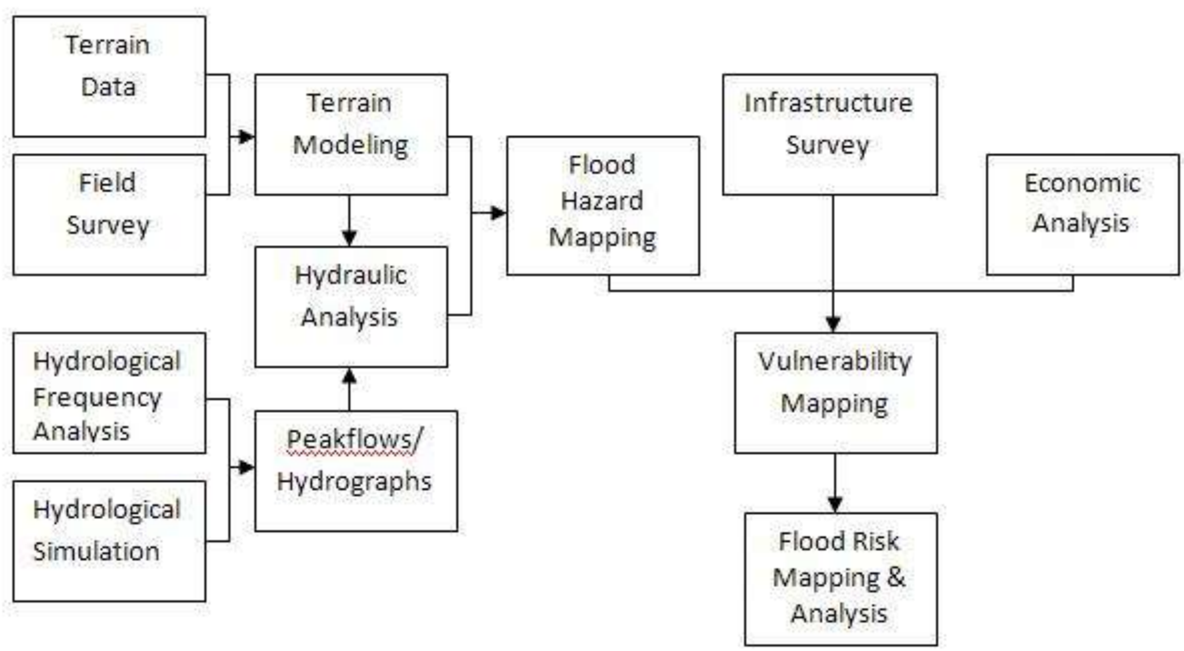
47. The objective is to make a reconnaissance assessment of possible structural flood protection and mitigation measures to be proposed for detailed investigation. The terrain and flood mapping will provide the required input for engineering studies for better flood protection and mitigation. Within this project, the activity should indicate the possible feasibility of specific measures and formulate concept proposals for further investigations and feasibility studies. The main activities are:

i. Desk study
ii. Compilation of concept proposals
iii. Report

48. This activity can be carried out by project staff and there are no required financial resources. Inputs are required from activities 2, 3 and 4. The expected duration is two months. The deliverables are the report and the concept project proposals.

## 7. Work Scheduling

49. The main linkages between various activities are shown in the below flowchart.




50. See tentative schedule on next page. The critical activity is the terrain survey as part of activity 3, which should be done in the dry season. A suitable starting date module therefore be July 2010, in which case the project would be completed in December 2011.

| Activity | month | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| **1. GIS structured database** | = | = | = | | | | | | | | | | | | | | | |
| **2. Hydrological analysis** | | | | = | = | | | | | | | | | | | | | |
| **3. Terrain topographical data** | = | = | = | = | = | = | | | | | | | | | | | | |
| **4. Hydraulic analysis** | | | | | | | = | = | = | = | | | | | | | | |
| **5. Empirical validation of theoretical hazard maps** | | = | = | | | | | | | | = | = | | | | | | |
| **6. Vulnerability information and mapping** | | | | | | | | | | = | = | = | | | | | | |
| **7. Stakeholders' involvement** | | | | | | | | | | | | | = | = | = | | | |
| **8. Finalized database and mapping** | | | | | | | | | | | | | | | | = | = | = |
| **9. Flood model** | | | | | | = | = | = | | | | | | | | | | |
| **10. Climate variability and change evaluation** | | | | | | | | | = | = | = | | | | | | | |
| **11. Flood protection and mitigation assessment** | | | | | | | | | | | | | | | | = | = | |

## 8. Required Resources (budget)

51. The estimated financial requirement for the project is N$ 14,950,000 as is detailed below. This excludes in-kind contributions by involvement of project staff and operational expenses, estimated at N$ 1,500,000.

| Activity | financial requirement (N$) |
|---|---|
| **1. GIS structured database** | **400,000** |
| **2. Hydrological analysis** | **-** |
| **3. Terrain topographical data** | **13,100,000** |
| **4. Hydraulic analysis** | **150,000** |
| **5. Empirical validation of theoretical hazard maps** | **100,000** |
| **6. Vulnerability information and mapping** | **200,000** |
| **7. Stakeholders' involvement** | **600,000** |
| **8. Finalized database and mapping** | **100,000** |
| **9. Flood model** | **100,000** |
| **10. Climate variability and change evaluation** | **200,000** |
| **11. Flood protection and mitigation assessment** | **-** |
| **TOTAL** | **14,950,000** |

52. At present, N$ 2,000,000 were requested for floodmapping on the development budget of the Hydrology Division for the 2010/11 and 2011/12 financial years. There is also a tentative World Bank fund commitment of the equivalent of N$ 1,000,000 following the PDNA study. The additional in-kind contributions, for involvement of project staff and operational expenses, are estimated at N $1,500,000.