MODELLING FLOOD EVENTS IN THE LOWER BICOL FLOODPLAIN

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Modelling Flood Events In the Lower Bicol Floodplain

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By

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From a son to a father,
for my late father M. Usamah B.

Abstract

Floods are the most serious and the most frequent natural hazard in the Bicol River Basin and cause substantial suffering, severe losses of life and economic damage. One reason why it becomes increasingly serious is that large part of the population live in areas susceptible to flooding. To minimize the damages to the lives and property caused by floods, it is essential to develop a system for flood risk management. Forecasting flood events that may occur at certain region using computer model can contribute to this.

In this research, a 1D2D flood propagation model was applied in the Lower Bicol Floodplain to simulate flood events for return period of 2, 5, 10, 25 and 50 years. This 1D2D flood model required three input parameters: a Digital Elevation Model, surface roughness coefficient of the floodplain and input hydrological data. The DEM was generated from interpolation of spot heights and contour lines obtained from different sources and scales. Input hydrological data were discharge and water level at four boundaries in the area with 15 minutes interval. The model was run five times for five different flood events for six days simulation.

The model results showed an increase in the inundation extent of about 50 % from flood with a return period of 2 years to the largest flood with a return period of 50 years. Positive correlation between the inundation depth, flow velocity and the probability of flood events was found, where the higher return period, the higher the depth of inundation and the flow velocities. Since there is no real measured data, the model was validated with the 2003 model of Nippon Koei in Bicol River Basin and Watershed Management Programme. The model result of flood extent showed that there was 95.59% agreement for return period of 5 years, 89.97% for return period of 10 years and 95.33% for return period of 50 years. For water level calibration, scatter plots of the model results and the reference model showed good agreement with 0.98 correlation coefficient for return period of 5 and 25 years and 0.99 for return period of 10 years. Indicator maps produced from modelling were further processed to create flood hazard maps. Understanding that the level of flood hazard can not be measured by single parameter, this research proposed hazard maps based on single and multiple categorisations. It was found that different parameters, either single or multiple, created different flood hazard maps.

Keywords*: flood, return period, 1D2D flood modelling, Lower Bicol Floodplain.*

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Abbreviations

1D	One Dimensional
2D	Two Dimensional
AIT	Asian Institute of Technology
AEP	Annual Exceedence Probability
ARI	Average Recurrence Interval
ASCII	American Standard Code for Information Interchange
BCEOM	Bureau Central d'Etudes pour les Equipements d'Outre-Mer
BRBFCIDP	Bicol River Basin Flood Control and Irrigation Development Project
BRBWMP	Bicol River Basin Watershed Management Project
DEM	Digital Elevation Model
GIS	Geographical Information System
ILWIS	Integrated Land Water Information System
KVR	Russian Space Forces
LIDAR	Light Detection and Ranging
NEDA	National Economic and Development Authority
NAMRIA	National Economic and Resources Information Authority
PAGASA	Philippines Atmospheric and Astronomical Services
SAR	Synthetic Aperture Radar
SRTM	Shuttle Radar Topography Mission
UNEP	United Nations Environmental Programme
USACE	United States Army Corps of Engineer

1. Introduction

1.1. Background

Floods are becoming increasingly important hazards in all around the world. Every year, river and coastal flooding in the world results in major loss of life and property. The United Nations report showed the results of disaster statistics collected worldwide during around 40 years period (1963-2003) and found that floods killed more people than any other type of disaster (22% all of deaths) and caused the most damage. The damage caused by the floods to the lives and properties is significantly higher than the damage done by any other natural hazards. In other words, major floods are the largest cause of economic losses from natural disasters and disaster-related deaths.

As floods are among the most severe risks on human lives and properties, there is always a need to prevent more loss from the possible effects of floods in the community. One of the ways to prevent more loss and risk in the future is by understanding the behaviour of the flood. Statistical analysis, for instance, can be used to study and observe the trend of the extreme values of discharge to predict the future events of flood. The recent development of climatological researches integrated with mathematical prediction can give us overview about the flood behaviour in one area.

Flood modelling is one of the ways to understand the flood behaviour. The modelling result can be used to obtain flood information for flood emergency planning. In flood prone areas, estimation of flood inundation and its risk is needed for the planning and operation of civil protection measures (e.g. dams, reservoirs) and for early warning or evacuation management.

1.2. Problem Statement

The Philippines is one of the most disaster-prone countries in the world. Water-related disasters (e.g. flood, typhoon, erosion, etc) are the most serious and most frequent of all hazards in the Philippines and cause substantial suffering, severe losses of life and economic damage.

In Philippines, one more reason that water-related disasters become increasingly serious is that large parts of the population live in areas susceptible to flooding. This is because the Philippines has developed the low-lying river deltas and coastal lands for wet-rice agriculture and urban settlement.

Floods in the Philippines' low lying areas are natural phenomena that occur frequently due to the geographical position and geomorphological circumstances of the region. As a result, over 60% of the population of Philippines are at risk of water disasters especially for flash flood (UNEP, 2002). These natural disasters have been aggravated also by inappropriate human activities.

The Philippines is a country of diverse topography, ranging from mountain to the low-lying areas near by the coasts. An example is Bicol river basin which is located on the Luzon Island, the main island in the Philippines. The report of Nippon Koei in River Basin and watershed Management Program 2003 says that the livelihood of people living in Bicol River Basin as well as their settlements are threatened by extensive flooding and inundation caused by tropical storms and typhoons that are frequent in that region (Nippon KOEI CO, 2003) . As recently reported, the flooding has increased in intensity and frequency in the last 10 years (Rondinelli, 2000). The situation has even been aggravated by several recent eruptions of Mayon Volcano, located in the southern part of the Bicol River Basin. These eruptions have resulted in an accelerated sedimentation of thick and highly erodable ash cover that disturbs the river systems and increases the flood hazard (Nippon KOEI CO, 2003). In the event of continued basin degradation, adverse and expanding effects of human activities on the floodplain and the effects of global warming, the outlook for the sustainable development of the basin appears bleak without coordinated and integrated planning and management.

Therefore, in order to minimize the damages to the lives and property caused by floods, it is essential to develop a system for flood risk management, one of which is by predicting flood events that may occur in certain regions that are susceptible to floods.

1.3. Research Objectives

1.3.1. Main Objective

The main objective of this research is to apply a flood propagation model in the Lower Bicol Floodplain to simulate the flood events with different return periods of floods.

1.3.2. Sub Objectives

- To develop detailed Digital Elevation Model of the Lower Bicol Floodplain
- To determine the flood extent, depth, flow velocity of flood and warning time of the inundation for different return period of flood event (2, 5, 10, 25 and 50 years)
- To create flood hazard map for certain return period of flood events
- To observe whether the model reliably predicts the flooding behaviour of the current floodplain

1.4. Research Questions

- What is the best data combination to produce the detailed DEM of the Lower Bicol basin?
- Which areas are likely to be inundated for certain return period of flood events? At what depth and when?
- Which areas are considered hazardous for certain return period of flood events?
- How well does the model fit with observations from past events of flood data?

1.5. Research Methodology

This research applies 1D2D hydraulic modelling to simulate the flood events with different return period of floods in the Lower Bicol Basin. It uses SOBEK software developed by WL Hydraulics Delft. In conducting 1D2D modelling, there are three input parameters needed. They are digital elevation model to represent the topography or floodplains, landcover map that is transformed into surface roughness coefficient map, and hydrological data. Hydrological data used in this research are discharge and water level obtained from the result of the model developed in 1991 by NIPPON KOEI in Bicol River Basin Flood Control and Irrigation Development project (BCEOM Consultants, 1991 ;Nippon KOEI CO, 2003). Discharge and water level hydrographs for the return period of 1.25, 5, 10 and 25 years were available. Values for return period of 2 and 50 years are derived from statistical interpolation and extrapolation

At the final step of this research, it is attempted to develop flood hazard maps for different return period of floods by incorporating several hazard parameters. It is different from the conventional way of making flood hazard map based on one single parameter, which is usually the depth of inundation. Multiple parameters for determining flood hazard map are obtained from the output of the modelling using Sobek 1D2D, which are flood map of spatial extent, inundation depth, flow velocity and warning time map. Integration of these indicator maps will produce a flood hazard map of the Lower Bicol Basin for different flood return periods. Methodology of this research can be seen in Figure 1-1.

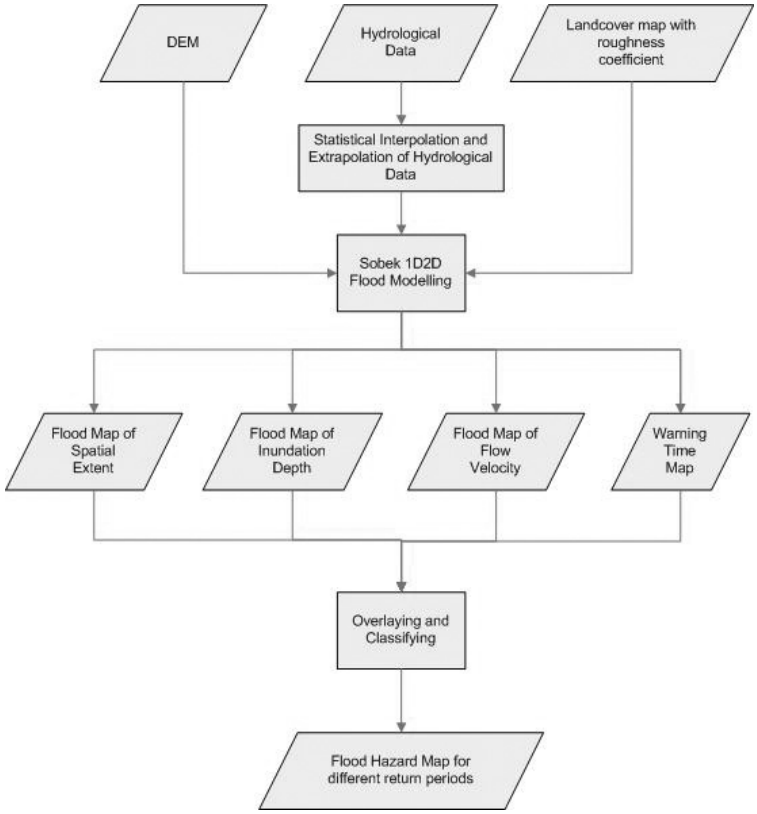


Figure 1-1 General flowchart of the methodology

1.6. Outline of the thesis

The thesis consists of seven chapters.

In introduction in chapter one, the research problems in the Lower Bicol Basin are explained and the research objectives are described. The methodological approach is also explained to give idea on how to achieve the objectives of the research.

In chapter two, characteristics and selection of the case study is introduced. The data available is also described. This describes what data is available, what data is gathered during data collection phase in the fieldwork and from which organization the data is obtained.

Introduction to the hydrodynamic modelling is given in chapter three. This chapter further explains about the use and the advantage of the combined 1D2D hydrological modelling and data requirement in the 1D2D modelling. Some pre-modelling results are also explained and shown in here, including the procedure of constructing digital elevation model of the study area, transforming the landcover map into the surface roughness coefficient, model schematization and input boundary before running the model. The model output is also described in this chapter

Chapter four shows the output of the model and the analysis of the flood events in different return periods. Comparison of each return period is explained in detail in here; include validation, sensitivity of the model and scenario developments of the model.

Integration of multiple indicators map produced from the modelling involving some parameters for flood hazard mapping is explained and shown in chapter five. It also compares multiple-parameter flood hazard map with single-parameter flood hazard map.

Chapter six is devoted to discussion of the result.

Lastly, chapter seven gives overall conclusions and recommendations. This chapter also summarizes the overall results and limitations of the model.

2. Study Area and Data Availability

2.1. Case Study Selection: Lower Bicol Floodplain

2.1.1. Study Area

The Bicol River Basin occupies 312,000 ha at the southern end of Luzon island, in the province of Camarines Sur and Albay. It consists of one major river basin, which is Bicol River and 10 minor river basins. The basin is about 130 km long and 25 km wide and is bounded along its length by the Ragay Hills to the southwest and a series of volcanoes to the northeast. The very active Mayon volcano is situated at the southern end of the basin. The southern part of the basin is drained by the Bicol River which flows nothwesterly from lake Bato, through a wide flat floodplain subject to frequent inundation, to its mouth at San Miguel Bay. The study area is focused on the Lower part of the basin, which is a coastal floodplain that lies between 13° to 14°N and 123° to 124° E.

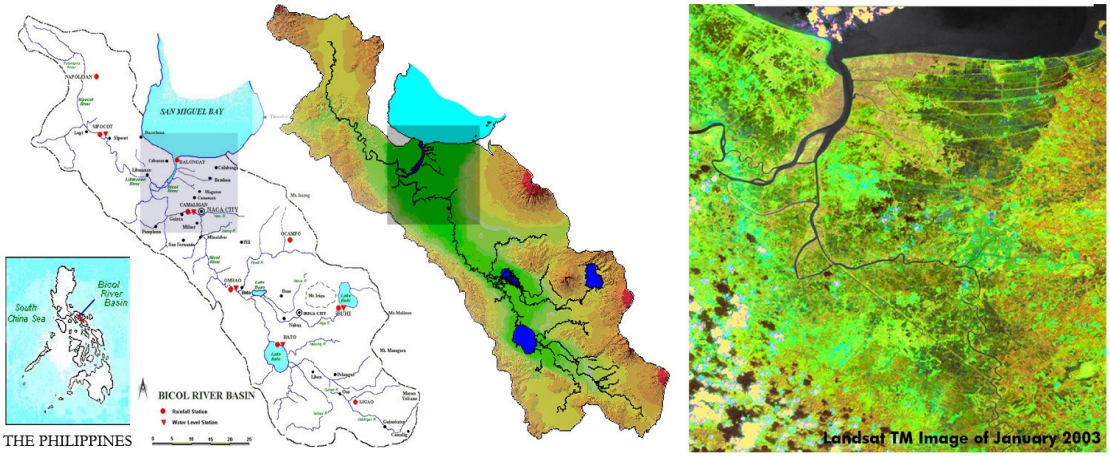


Figure 2-1 Location of the study area

A number of small towns are located in the floodplain and the largest of these is Naga City. Storm surges caused by Typhoons increase the flooding problem at the towns and the surrounding farmlands.

The Bicol River Basin is a complex river system, much of which is low lying with low gradients. The floodplain is wide and suffers from perennial flooding problems caused by typhoons. Even in low magnitude-high frequency events, large areas are submerged

for periods of weeks with depths of water often in excess of two meters (BCEOM Consultants, 1991)

The Bicol River runs primarily from south to the north with the additional inflow discharge from Tributaries, e.g. Naga River. Near the estuary at the San Miguel Bay, the Libmanan River, coming from the west, joins the Bicol River. The river banks are normally very low and in some parts, the river is even higher than the ground surface of the backswamps. Most buildings and residential areas are within 1 buffer zone of two kilometres from the river, thus highly susceptible to floods.

The Lower Bicol Basin has been experiencing increasing frequency of flooding, both in terms of extent and duration of flood. It comprises of 12 municipalities and all are prone to flood (see Figure 2-2). The floods have resulted in increasing loss of life and property both in urban and rural areas, as most of the activities lies on the floodplain.

Figure 2-2 Municipalities lying on the Lower Bicol

2.1.2. Geology and Geomorphology

The Bicol River is bounded on the northeast by the Bicol Cordillera, which consists of a chain of volcanic mountains including Mount Mayon (2,421 m), Mount Masaraga (1,377 m), Mount Iriga (1,196m) and Mount Isarog (1,966m). On the southwestern side, lie the

Ragay hills, which consist of folded and faulted sedimentary formations including limestone, siltstones, conglomerates and shale, with an average elevation of 300 m. In between these higher areas, lies the Bicol plain comprising of thick alluvial deposits consisting of sand, silt and clay (NIPPON KOEI, 1991).

The three main geomorphological features found in the area are the estuarine plain, the river floodplain and the piedmont plain with valleys of incised creeks. The estuarine plain is level to nearly level and consists of fine fluvial and marine deposits over sandy layers with marine shells. The fluvio-marine deposits are usually saline at depths of approximately 1 meter. The river floodplain is made up of mixed alluvium. The piedmont plain on the fringe of the Ragay hills consists of fine alluvium clay and reworked colluviums (NIPPON KOEI, 2003).

2.1.3. Climate

A tropical climate, controlled by air stream systems including the monsoons and Pacific trade winds, predominates over the area. A characteristic is the absence of a pronounced dry season, through the period from February to April is being relatively dry. Heavy precipitation generally occurs during the months of October to December. Mean annual rainfall varies from about 1,600 to 4,300 mm with an average of 2,200 mm on the floodplain. The basin is protected from storms from the east by the volcanoes but is exposed to storms from the northeast monsoon during the months of November through February by way of San Miguel Bay and the valleys to the north. The main temperatures are high throughout the year with the daily mean temperature in the range of 24 to 28^{o}C (NIPPON KOEI, 2003).

2.1.4. Tides

Besides the riverine flooding from the three rivers flowing in the Lower basin (Bicol, Naga and Libmanan River), the tides also influence the flood behaviour. If the flood occurs when the tide is high, the amount of water stored in the channels is also more abundant thus making the water overflows the river bank and the floodplain faster. Storm surges in the San Miguel Bay, related to typhoons, aggravate this situation.

Data analysis from Balongay, which is very close to the mouth of the Bicol River Basin at San Miguel Bay, gives the tidal curves which is used to derive mean tidal elevations at Balongay (BCEOM Consultants, 1991). It is summarized below:

Maximum tidal level	+1.33 m
Mean high water	+0.69 m
Mean tide level	-0.03 m
Mean low water	-0.74 m
Minimum tide level	-1.44 m

2.2. Data Availability

As the study area has been studied before, there have been some data sets available that can be used to do some preliminary analysis. Those are listed in Table 2-1:

Table 2-1 Available data for preliminary study

No	Data	Format
1	Topographic maps of Libmanan and Naga sheets, scale 1:50,000	Printed and digital
2	Landsat Image spatial resolution 30 m, taken Januari 2003	Digital
3	Aster Image spatial resolution 15 m, taken April 2002	Digital
4	KVR image Russian satellite spatial resolution 1 m, taken in 1991	Digital
5	Feasibility Report of Bicol River Basin Flood Control and Irrigation Development Project Volume 1, 4, and 5, by BCEOM French Engineering Consultant, August 1991	Printed
6	Final Report River Basin and Watershed Management Program, Water Resources management Plan Formulation and Phase I Project Feasibility Study for the Bicol River Basin, by NIPPON KOEI, April 2003	Printed
7	Landcover map, Otieno (2004)	Digital

These available data are used during the preliminary analysis. This includes identification and delineation the boundary of the study area for preliminary understanding of the topography of the study area.

One of the focuses of the fieldwork was to gather secondary data at various sources either public or private organizations. The data collection was focused on the topographical and hydrological data, which are scattered within different organizations. In addition, some digital data were also collected either in the regional offices within the Bicol Region or at the main office in Manila.

The data used in this research comprises both digital and hard copy information as described from different source of organizations in Table 2-2 and Table 2-3.

Table 2-2 Available data from NEDA (National Economic and Development Authority)

No	Data obtained	Format
1	River Network of the study area	Printed
2	River Cross Sections of Bicol, Naga and Libmanan River and cut off channels scale 1:2,000	Printed & digital
3	Toposheets scale 1:4,000 made by BCEOM French Engineering Consultant, contour interval 0.25 m, covering the lower part of the study area	Printed
4	Toposheets scale 1:4,000 made by Bicol River Basin Flood Control and Irrigation Development Project (BRBFCIDP), contour interval 1 m	Printed
5	Spot height of the whole Bicol Basin from topo sheets 1:10,000	Digital
6	Contour lines of the whole Bicol Basin from topo sheets 1:10,000	Digital
7	Output of the MIKE-11 Model conducted by Nippon Koei in BRBWMP, 2003, which are discharge upper boundaries (Bicol, Naga, and Libmanan River) and water-level lower boundary in San Miguel Bay, for return period of 1.25, 5, 10, and 25 years	Digital

Table 2-3 Available data from NAMRIA (National Mapping and Resources Information Authority)

No	Data obtained	Format
1	Geology map covering the whole Bicol basin scale 1:50,000	Digital (.shp file)
2	Municipal boundary map of the whole Bicol basin scale 1:50,000	Digital (.shp file)
3	Slope map covering the whole Bicol basin scale 1:50,000	Digital (.shp file)
4	Soil map covering the whole Bicol basin scale 1:50,000	Digital (.shp file)
5	Lithology map covering the whole Bicol basin scale 1:50,000	Digital (.shp file)
6	Landcover map of the whole Bicol Basin scale 1:250,000	Digital (.shp file) and printed

3. Hydrodynamic Modelling

3.1. Introduction

Over the past decades, hydrodynamic modelling has become a frequently used tool for studies in hydraulic and environmental science and engineering. In addition, the more widely used mathematical models for operational purposes in fluvial hydraulics are 1D and 2D models, which are used for the simulation of the behaviour of the hydrodynamic system.

This study applies a 1D2D hydraulic model to simulate the inundation process on the Lower Bicol floodplain in the Bicol region, the Philippines for different return period of floods which are 2, 5, 10, 25 and 50 years.

3.1.1. Description of the hydraulic model

This Modelling uses Sobek-rural, a product of the main Sobek line of hydrodynamic water flow models developed at WL|Delft Hydraulics. This software package integrates a one-dimensional (1D) modelling package with a two-dimensional (2D) hydrodynamic prediction package thus it has the functionality of including the one-dimensional river/channel flow and two-dimensional overland flow, which is called “Sobek 1D2D” (WL-DELFT_HYDRAULIC, 2003). This 1D2D system is designed for the simulation of overland flooding or inundation when in normal conditions (in case of no flooding) hydrograph can be modelled as a one-dimensional (1D) network. If larger areas are inundated then assumptions for 1D flow are normally no longer valid and in that case, the system becomes truly two-dimensional (2D).

The computational domain is splitted into a one-dimensional part that represents the river network and a two-dimensional part with rectangular computational cells that represents the floodplain topography. The equations to be solved are based upon the momentum balance and the conservation of mass. For the momentum balance the 1D and the 2D system remain strictly separated. That means that velocities or discharges belong either to the 1D part or to the 2D part. For the conservation of mass, being a scalar quantity, the appropriate 1D and 2D volumes are combined so that they share the same water level (Frank, 2001) as seen in Figure 3-1.

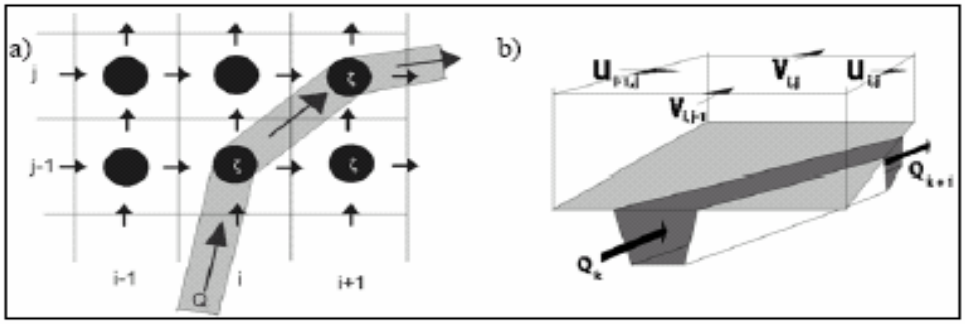


Figure 3-1 Schematization of the hydraulic model: a) combined 1D2D staggered grid; b) combined infinite mass volume for 1D2D computations.

Both the 1D and 2D grids are staggered (Figure 3-1a). This means that for the finite volume approach applied, the momentum volumes are different from the mass volumes and that vertical velocities and shear stress interaction between the 1D and 2D flow are neglected. For each momentum volume the following law is applied:

Rate of change of momentum + transport of momentum + hydrostatic pressure + friction losses = 0

Equation 3-1

The numerical implementation is such that in the vicinity of steep gradients proper shock conditions are being fulfilled, both for 1D and 2D volumes (Stelling, 1998).

The interaction between the 1D and the 2D part takes place via mutual volumes, see figure 3-1b. For mutual 1D/2D mass volumes the following equation is solved:

$$\frac{dV_{i,j}(\zeta)}{dt} + \Delta y\left((uh)_{i,j} - (uh)_{i,-1,j}\right) + \Delta x\left((vh)_{i,j} - (vh)_{i,j-1}\right) + \sum_{l=K^1_{i,j}}^{l=K^1_{i,j}} (Q_n)_1 = 0$$

Equation 3-2

Where:

ζ	water level above plane of reference (the same for 1D and 2D)
V	combined 1D/2D volume
u	velocity in x direction
v	velocity in y direction
h	Total water height above 2D bottom
Δx	2D grid size in x (or i) direction
Δy	2D grid size in x (or j) direction
Qn	Discharge in the direction normal to the mass volume faces
$Ii,,j,l,K,L$	integer number for nodal point numbering

For figure 1b, equation 3-2 becomes:

$$\frac{dV_{i,j}(\zeta)}{dt} + \Delta y\left((uh)_{i,j} - (uh)_{i-1,j}\right) + \Delta x\left((vh)_{i,j} - (vh)_{i,j-1}\right) + Q_{k+1} - Q_k = 0$$

Equation 3-3

After discretisation in time by the BETA method (Stelling, 1998), the velocities are eliminated by substitution of the momentum equations into the continuity equation. The resulting system is linear for purely 2D volumes, but if a 1D part is involved the equation might be non-linear with respect to the volume V(ζ). This is solved by Newton iteration. The resulting linearised equations, per Newton iteration step, are positive definite and symmetric (Casulli, 1990). The method used for the solution is a combination of the so-called minimum degree algorithm (Duff, 1986) and of the pre-conditioned CG (conjugate gradient) (Golub, 1983).

The continuity equation is discretised in a way that excludes the possibility of negative volumes. This allows for very efficient and also realistic flooding of dry beds when the 1D rivers are flooding their 2D surroundings. In normal conditions, i.e. if there is no flooding, the 2D part is not activated. This means that in equation 3-2 the *uh* and *vh* values are zero (Frank, 2001).

3.1.2. Advantages of Combined 1D-2D Modelling

Combined 1D2D modelling has several advantages. The first advantage of combined 1D-2D modelling is bringing the model behaviour closer to the real physical behaviour. Thus simulating the flow in river/channel network with extensive details within 1D system. To name a few, incorporating structures, like weir, culverts, gate, and on-line controls of these structures along the stretch of river/channel. While simulating the overland flow with extensive details within 2D system. To name a few, incorporating physical obstructions, like roads, railways, dikes, etc. Secondly, Using combined 1D-2D modelling often allows the grid cells significantly larger than purely 2D modelling. The reason is that, using combined 1D-2D modelling, the river, channels, streams etc is not modelled within 2D system, but as 1D system. For a very narrow channel/stream or curving streams, one requires within purely 2D system a high local grid refinement. This would make 2D system numerically less feasible and almost impossible to model. Here combined 1D-2D modelling often proves advantageous. Thirdly, the modeler's works in the same user interface, for both pre-processing of data as well as post-processing of the results (Dhondia, 2002)

In general, integration offers wide range of modelling options. It is also easy to combine an urban drainage model to simulate the street flow, and flow over, for example, parks and parking places (Bishop and Catalano, 2001). This combined 1D-2D system with urban drainage system and street flow, also developed at WL|DELFT HYDRAULICS, is named as "Sobek-Urban". Further, the combined 1D-2D modelling is capable of modelling problems related to flood hazard and risk mapping (Frank, 2001).

3.2. Model data input

There are generally two types of data sets that are used in this study for the input of the model: spatial and non spatial data. Spatial data include digital elevation model (DEM), one-dimensional channel network, structures and landcover map which is transformed into spatial map showing surface roughness coefficients. Non spatial data are inflow discharge and water level.

For 1D2D hydraulic modelling, there are four parameters needed for the input. They are 1) Digital Elevation Model to represent topography and river cross sections, 2) roughness data to represent the resistance to water flow on to different vegetation types along the river channel and the floodplain, 3) embankment and other artificial structure to make the model work as close as to the real condition and 4) boundary data in which time series of flow or water levels or Q-H relation can be defined. In general, required data for 1D2D hydraulic Modelling can be seen in the Figure 3-2.

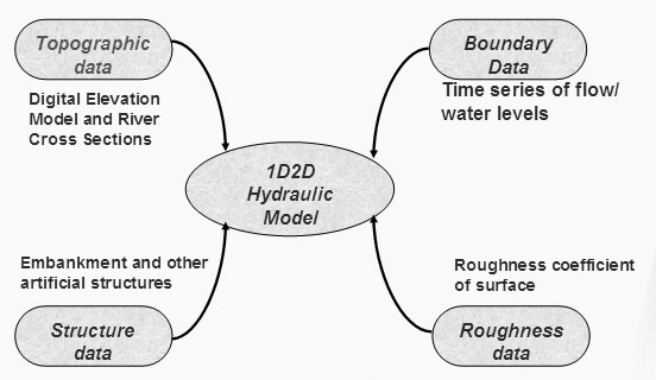
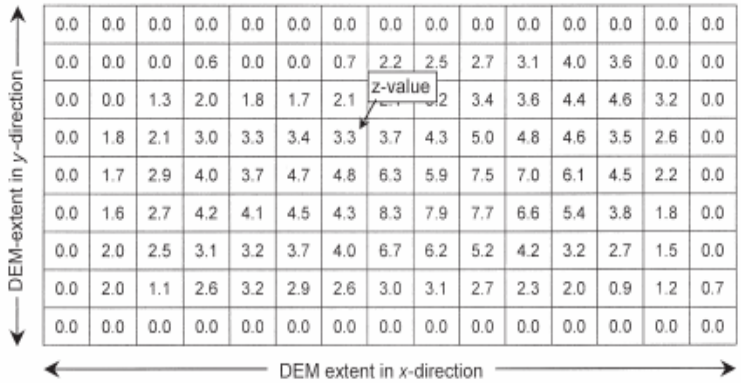


Figure 3-2 Parameter input for 1D2D hydraulic modelling

3.2.1. Construction of DEM

A digital elevation model (DEM) is a digital representation of a portion of the earth's surface. It has long been known that DEMs have a potential for solving theoretical and applied problems in earth science. DEMs also have a major role to play in geographic information systems (GIS), hydrological Modelling (O'Callaghan and Mark, 1984), analysis of visibility (Lee and Stucky, 1998) and hazard mapping (Gruber and Haefner, 1995).

In 2D flood modelling, the Digital Elevation Model is considered as the foundation of the model on which the water will flow. Thus, the representation of the terrain in a DEM is a very important thing to consider in the modelling. The more represented the terrain, the more accurate the model is and the closer to the real flood condition. Therefore, constructing the DEM is one important thing in modelling preparation since if properly created, a DEM constitutes a convenient tool for illustrating inundation effects over a specific area.



0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.6	0.0	0.0	0.7	2.2	2.5	2.7	3.1	4.0	3.6	0.0	0.0
0.0	0.0	1.3	2.0	1.8	1.7	2.1	[illegible]	[illegible]	3.4	3.6	4.4	4.6	3.2	0.0
0.0	1.8	2.1	3.0	3.3	3.4	3.3	3.7	4.3	5.0	4.8	4.6	3.5	2.6	0.0
0.0	1.7	2.9	4.0	3.7	4.7	4.8	6.3	5.9	7.5	7.0	6.1	4.5	2.2	0.0
0.0	1.6	2.7	4.2	4.1	4.5	4.3	8.3	7.9	7.7	6.6	5.4	3.8	1.8	0.0
0.0	2.0	2.5	3.1	3.2	3.7	4.0	6.7	6.2	5.2	4.2	3.2	2.7	1.5	0.0
0.0	2.0	1.1	2.6	3.2	2.9	2.6	3.0	3.1	2.7	2.3	2.0	0.9	1.2	0.7
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 3-3 Schematic example of a grid underlying a DEM and the cell elevation values determining the topography

The DEM used in this study represents the Lower Bicol floodplain's surface as spatially referenced regular grid points where each grid point represents a ground elevation value. The DEM can be seen as a grid, or matrix, with each cell having *x* and *y*-coordinates and an elevation value, *z* (Blomgren, 1998). Figure 3-3 shows such a grid. The number in each cell denotes the elevation in that particular cell.

The basic data for a DEM is based on terrain elevation observations that are derived generally from one of four sources (El-Sheimy, 1999):

1. Digitised contours
2. Photogrammetric data capture (including aerial photography and digital satellite imagery)
3. Ground surveying
4. Active sensors, such as SAR, SRTM and LiDar.

DEMs derived from contours are perhaps the most common of all sources. This is because digital contour data have been developed from analog maps for the longest time compared with the other sources. Contours from analog maps can be digitized by manual digitizing, semi-automated line-following, or automatic raster-scanning. The contours created from digitizing are then registered, vectored, edited and tagged with elevation values.

Photogrammetric data capture encompasses two methods for deriving remotely sensed data: aerial photography and digital satellite imagery. Both these methods have been used to generate accurate high-resolution topographic data. There are also a number of newer sources, such as Radar and Laser Altimetry, and Synthetic Aperture Radar (SAR) Interferometry, which are also being developed for deriving topographic data. However, for larger areas, LiDar is the most accurate way of producing DEM.

For specific purposes, e.g. cross sections, data derived from surveying is the most accurate, if carried out correctly. Such high levels of accuracy, however, require a lot of time and man-power in the field. Therefore ground surveys are costly, time consuming and are only feasible for specific projects involving small areas.

3.2.1.1. Construction of the DEM of Floodplain

In this study, the DEM of the floodplain of the Lower Bicol Basin is obtained from the integration of contour lines and spot heights from different data sources with different scales. At the southern part of the study area, the elevation data are obtained from 1:4,000 topographic maps. Some parts of the southern part of the study area were adopted from the previous work of J. Otieno (2004). At the northern part of the study area the elevation data are obtained from the integration of 1:10,000 and 1:50,000 topographic maps because larger scale maps were not available. The digital contour map from 1:10,000 topographic map was already available from NEDA Office. The two different data sets were combined with each other to produce the final DEM of the study area as seen in Figure 3-4. The methodology for creation DEM, as part of creation of the final DEM can be seen in the Figure 3-5.

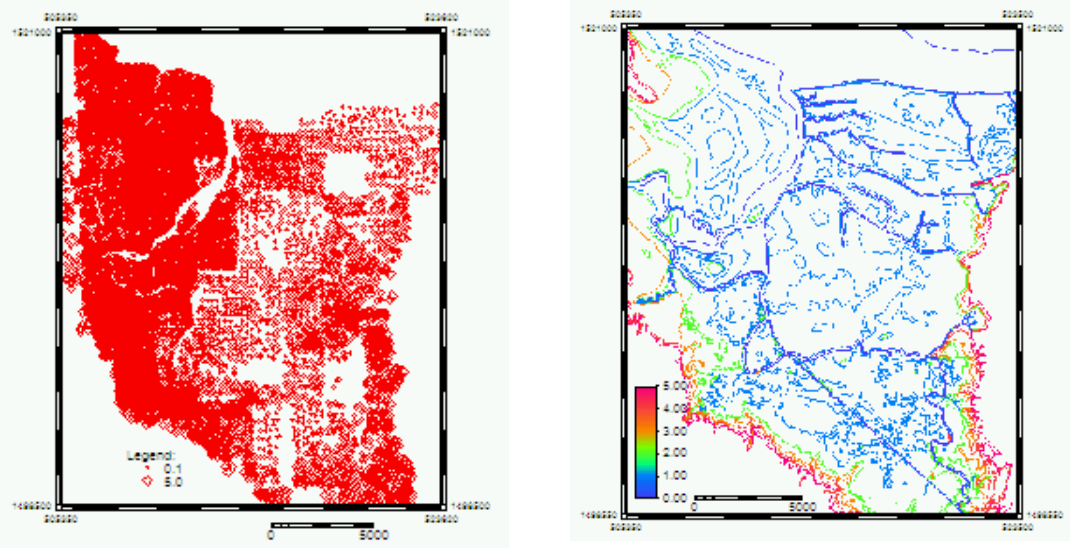


Figure 3-4 Spot heights (left) and isolines (right) taken from different data sources and scales (1:4,000 and 1:10,000) to produce DEM.

3.2.1.2. Construction of the DEM of Embankment

To represent the topography in the study area as real as possible, it is important to include the structures that are present in the study area that affect the flow of water like the river network, embankment, and the rail road network. The structures should be defined differently from the other features in the digital elevation model in order to be able to identify them in the model.

The embankments were digitized from the topographic maps scale 1:4,000 and 1:10,000. The segment maps were glued together and a point map was created with a unique identifier. An attribute table was created, linked to the segment maps, with a column that shows the actual height of embankment that were obtained from the topographic map at different distances. Using the table, an attribute map was created to get the point map of embankment height. Interpolation method of nearest point was done to obtain the embankment height of the study area. After the process of crossing and creation of attribute map, DEM of embankment was created as seen in figure 3-6.

3.2.1.3. Construction of the final DEM

The DEM of the floodplain and the embankment were combined using the function of IFF command and then visually inspected to check whether there were any irregular values that needed adjustment. The study area was masked out from the combined DEM and then re-sampled to a 50-m pixel size to be used for the input of the model. The methodology of constructing the final DEM can be seen in the Figure 3-5, while the final DEM can be seen in the Figure 3-6

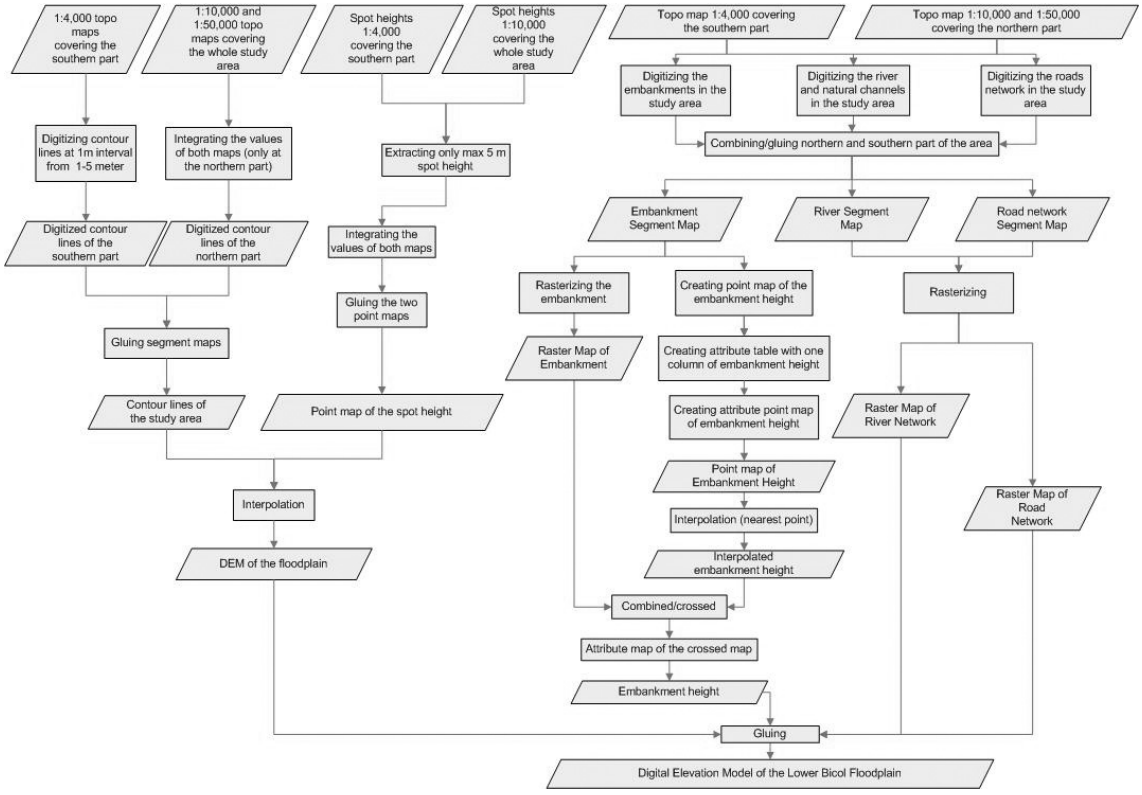


Figure 3-5 Flowchart creation of Digital Elevation Model of the study area

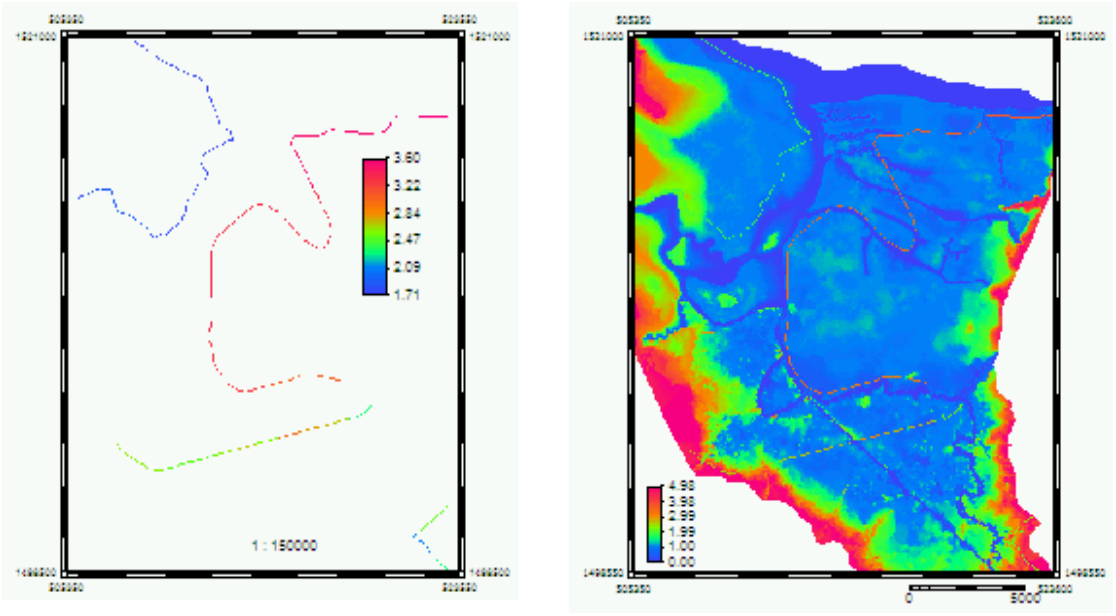


Figure 3-6 DEM of embankment (left) and Final Digital Elevation Model (right)

3.2.1.4. Pixel Arrangement in Hydrological Network

In the 2D model, the elevation values in the DEM determine the direction of the water flow. In Sobek, water can leave a pixel to any of the adjacent pixels. Diagonal flow is not possible as can be seen in Figure 3-7.

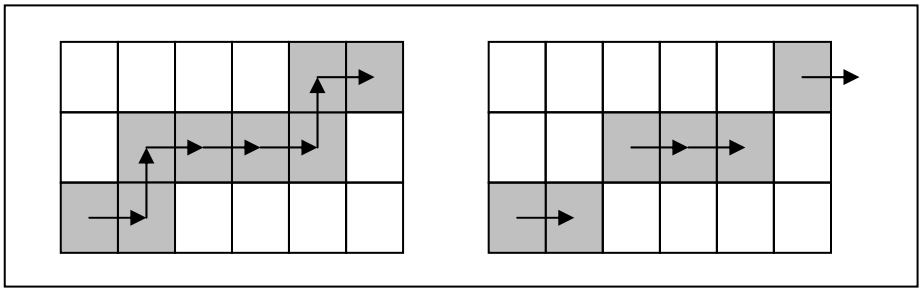


Figure 3-7 Water flows into pixel alignment as seen on the left, while water can not flow in the pixel alignment at the right

In the real model, it can be proven that the water flows through a continued pixel as can be seen in Figure 3-8.

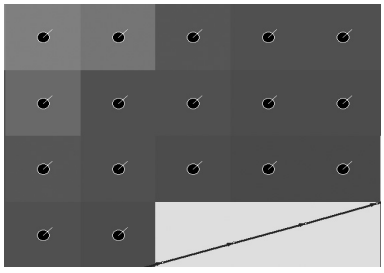


Figure 3-8 Pixel arrangement in SOBEK interface

3.2.1.5. Pixel Arrangement in Embankment

In order to be able to identify the embankment in the DEM, it should be defined differently from the other features by arranging pixel values representing elevation. In principle, the value of the embankment must be higher than the surrounding pixel in order to be able to block the water.

Figure 3-9 shows an example of a barrier on the floodplain. On the occasion where the water is higher than the embankment height, the embankment can be overflowed. The pixel alignment in the embankments can either be side by side or joined at the edges to block the flow of water, as seen in Figure 3-9.

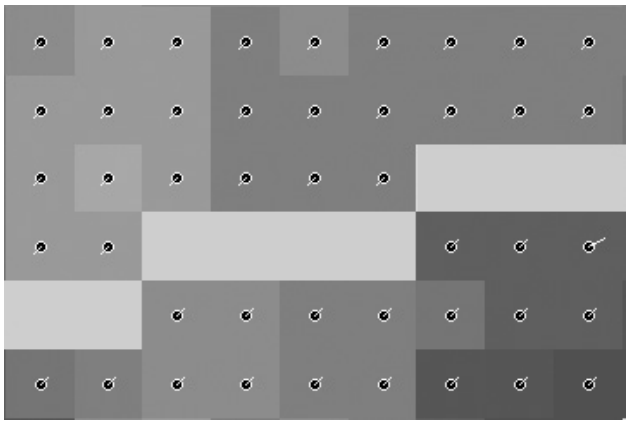


Figure 3-9 The blocking of the water due to the presence of embankments

3.2.2. Development of the Landcover map

The basis of the landcover map used in this study was the landcover map developed by J.Otieno (2004). For this study, Otieno's map was complemented with a larger-scaled landcover map made by NAMRIA the Philippines. Otieno did the landcover classification by visual interpretation of the image. Units of uniform landcover were digitized on screen and classified according to the Corrine Classification method.

During the preliminary analysis, there were some adjustment to the available landcover map based on the analysis of satellite images and aerial photographs. In addition, some changes were also made after doing some ground-truthing when conducting fieldwork.

The landcover of the study area consists of eight classes among of which rice paddies occupy 72.8 % of the territory. Residential areas are located along the main streets and some people also live on the river banks as most of the activities depend on the river. The landcover map and graphical comparison of the type of landcovers developed in the study area can be seen in the Figure 3-10.

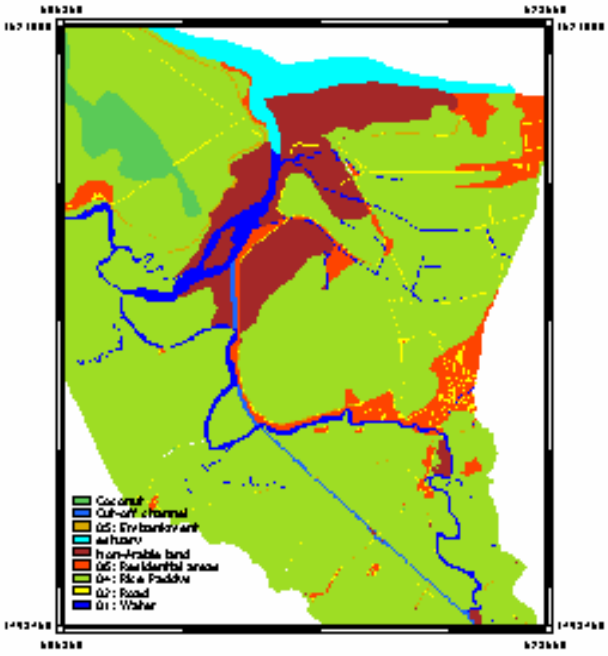


Figure 3-10 Landcover map of the study area

3.2.3. Transformation of Landcover map into Surface Roughness Coefficient map

In flood modelling, the resistance to flow is required to show the flood behavior on the floodplain. The resistance of flow is parameterized by roughness coefficient which represents the bed forms and vegetation of various types located along the banks and floodplain. In addition to flood, the type of landcover influences the flood behaviour in Bicol flood plain since water flow experiences friction that slows down the movement. In this case, it is important to determine the characteristic of the channels and the floodplain in terms of resistance to the flow of the water. To understand the relation or the effect of different landcovers developed on the floodplain and the flood behaviour, it is important to transform the landcover map into a map that displays the spatial distribution of roughness coefficient. Among many available methods of selecting surface roughness coefficient, Manning roughness coefficient is used in determining the surface roughness coefficient in the study area.

There is a tendency to regard the selection of roughness coefficients as either an arbitrary or an intuitive process. Specific procedures can be used to determine the values for roughness coefficients in channels and floodplains.

The Manning's resistance coefficient *n*, reported in numerous hydraulic publications, is founded on empiricism (USACEArmy, 2001). It does not address the degree of turbulence or the interaction between the flow and boundary. The empiricism of this coefficient limits its accuracy when applied to conditions somewhat different from those from which it is derived. However, Manning's method is widely used due mainly

to the large volume of reference data available to correlate resistance coefficients with boundary conditions.

In relation to flood behaviour, the roughness through each element will be computed using Manning's equation. To be able to do this, Manning's *n* must be specified by the user and this depends on the types of landcover.

Table 3-1 Manning's coefficient values of different landcover

Landcover Class	Manning's
Coconut	0.200
Cut-off Channel	0.033
Embankment	0.250
Estuary	0.025
Non-Arable Land	0.001
Residential Areas	0.200
Rice Paddies	0.100
Road	0.100
Water	0.033

In this study, the values of Manning's coefficient (Table 3-1) were adopted from previous detailed surveys that were carried out in the area (Asian Institute of Technology, 1975; BCEOM Consultants, 1991). Hence, based on the Manning's coefficient given in the table 3-1, the spatial surface roughness map of the study area can be seen in Figure 3-11.

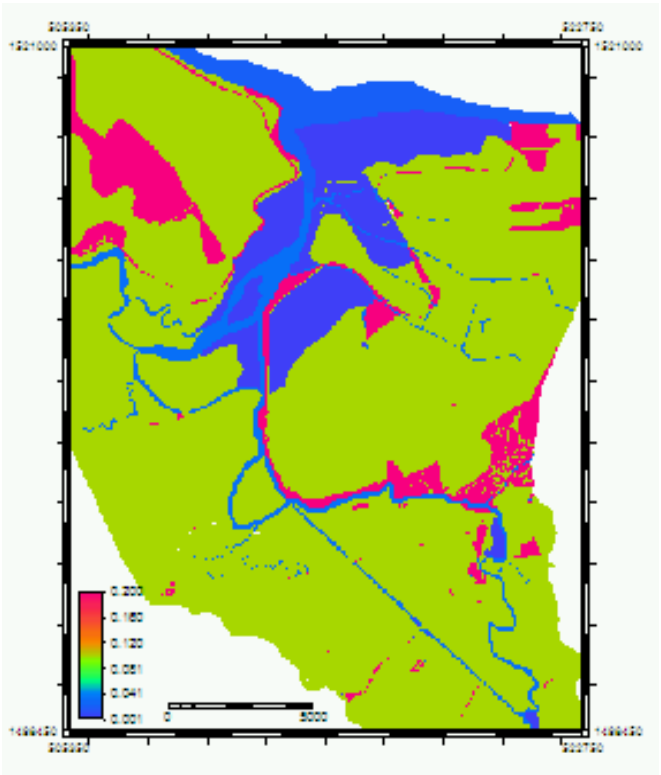


Figure 3-11 Landcover map with Manning's surface roughness coefficient

3.3. Model Schematisation

The data input and editing interface in SOBEK is called NETTER. NETTER offers the possibility to set up the schematisation on top of a background GIS map. NETTER also offers advanced analysis tools to show model result attached to the schematisation. Its window based user interface makes it easy to input and edit geometric data.

NETTER has two edit models. The first mode is the mode to set up the schematisation, e.g. by adding new nodes. The second edit mode is the mode for editing the attribute data. In this mode, one can give attributes to the schematisation objects. It is also important to know that SOBEK works with nodes which have different functionalities. NETTER also provides two separate menu bars to input and edit 1D feature like river and other drainage channels and 2D grid layer representing the floodplain.

3.3.1. Schematizing the 2D Network

To start schematizing, it is important to have the DEM imported to the NETTER. The DEM that has been developed and exported into ArcInfo ASCII format file can directly be inputted to the schematization using "2D grid" tool. The NETTER is equipped with user-friendly grid value editing facility in the grid cell editor. Figure 3-12 shows the imported 50 DEM of the study area with the river network as 1D feature. The small window interface shows the pixel values of each cell. With this, the values of each cell can be edited manually based on the row and column number using the grid cell editor. This is very useful when it is required to edit the DEM for various simulations in different scenarios.

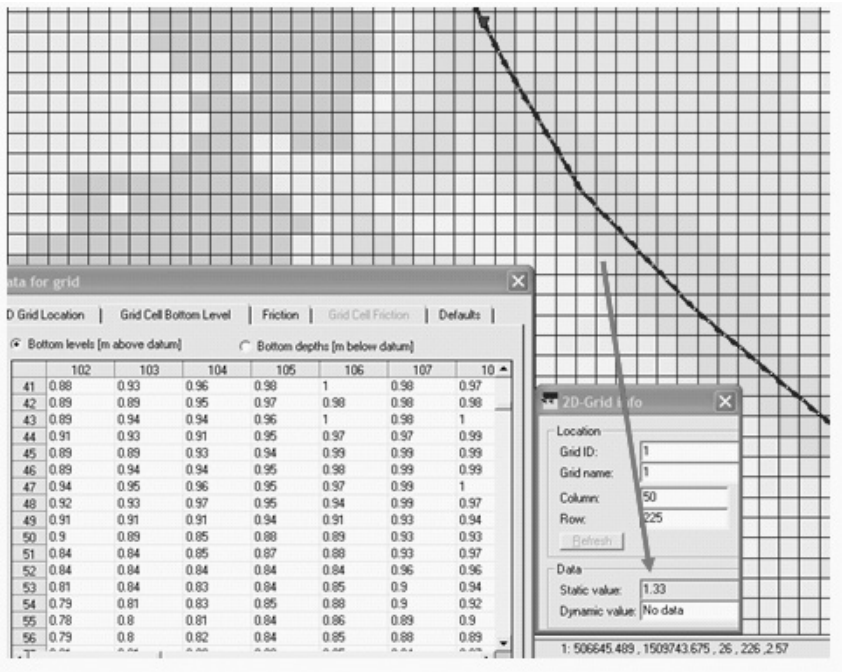


Figure 3-12 2D grid and 2D grid cell info and editor

After importing the DEM, the flow boundary condition should be defined and be put on the 2D schematisation. The flow boundary conditions will be connected using flow connection node in order to be able to define the 1D component. This will be explained detail in section 3.3.2. The complete schematization of the 2D network can be seen in Figure 3-13.

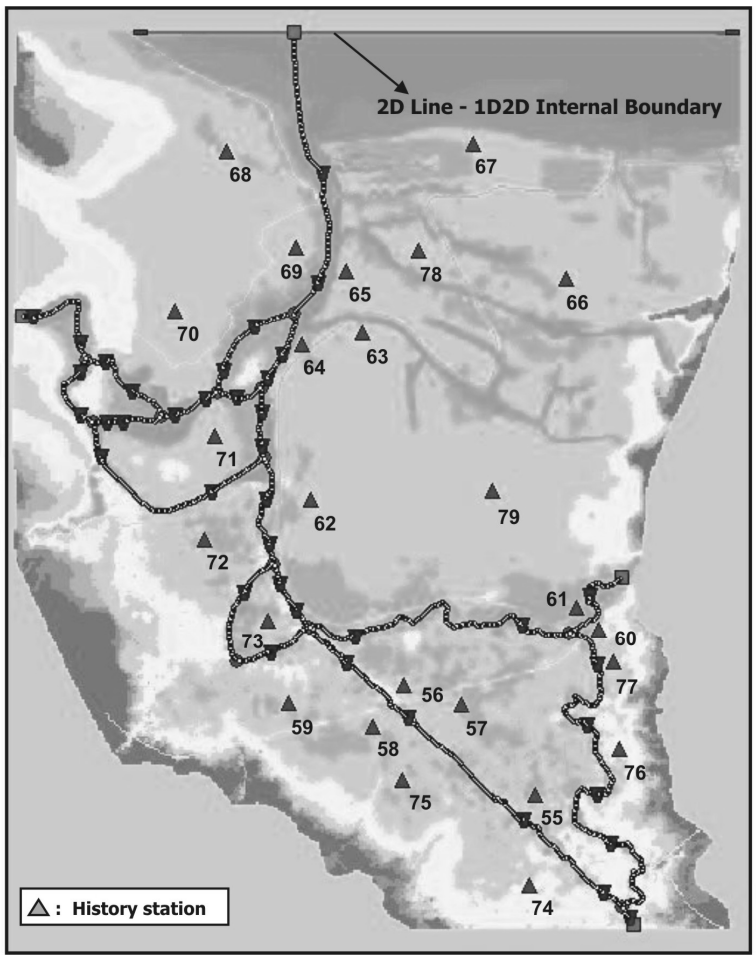


Figure 3-13 Schematisation of 2D Network with history stations

To determine the exact values of all parameters, e.g. water level variation in time on specific locations in the 2D grid, some nodes called history stations are used (Figure 3-13). This history station is especially useful for getting a quick idea as to how the water flows through the 2D grid system. The output from this history station is available for all selected parameters (i.e. water depth, velocity) and can be placed at every 2D grid cell in the schematisation. This type of node does not have any input parameters connected with it. It is purely a means to select certain 2D grid cells where exact output is required. When this node is used, the additional output will be available as 'results at history stations' in Netter.

3.3.2. Schematizing the 1D Network

The first thing to do when starting 1D schematisation is creating 1D network system that represents the water system. Whether it is a river, channel or sewer system: the principles are the same: it will be a GIS-based network or grid.

Creating 1D network is done by defining a reach that represents a river. A reach is always defined as connection between two so-called connection nodes. First, the 1D river system is defined in the NETTER using 1D nodes. The result is a straight-line river network that then has to be shaped to match the location of the river. This is done using "edit reach vector".

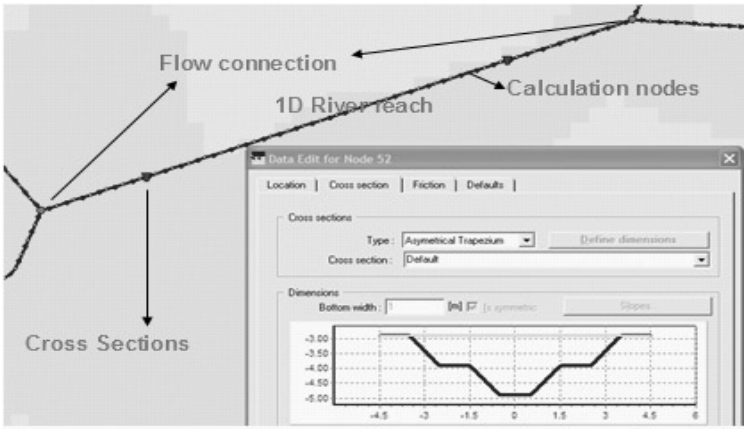


Figure 3-14 1D network and cross section in SOBEK

Figure 3-14 shows a 1D river reach, two cross sections and several grids along the reach. At the background of the network, the DEM is shown. Within "reach" function, additional reach calculation point can be defined. In this study, an interval of 50 meter was chosen. Later, various nodes/objects can be placed upon the reach as the attribute data of 1D component.

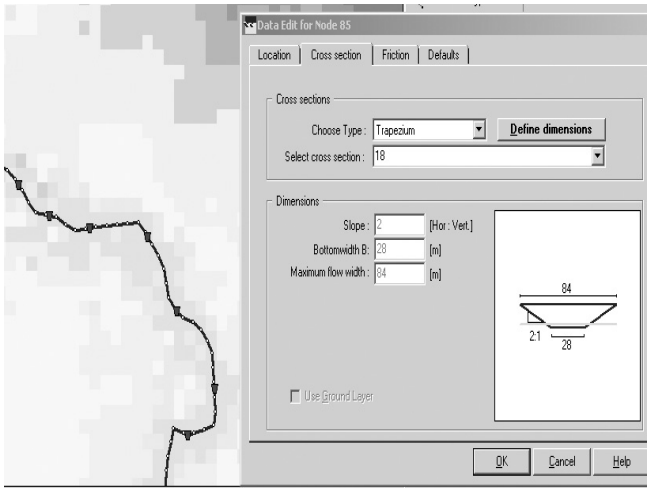


Figure 3-15 Cross section as representation of river and its input data screen

In 1D schematisation, one reach should contain at least one cross section showing the profile of the river. The more cross sections data, the better represented the river. SOBEK will interpolate the values within two cross sections so that all points within the river will have values that represent the river. Figure 3-15 shows some cross sections within one reach with its window input node. The complete SOBEK 1D node structure for river network is shown in Figure 3-13, together with the 2D schematization network.

Cross sections may be defined at arbitrary locations in the model. Depending on the situation, Sobek (Flow Module) constructs cross sections at the calculation points by way of constant extrapolation or linear interpolation. If there is only one cross section defined at a reach, this cross section and its bed level are applied over the whole reach at all the calculation reach. Figure 3-16 shows an example of the way the cross sections are interpolated and extrapolated.

During the 1D schematization, Flow-Cross sections node input are used to define the river characteristics and it requires the following river parameters:

1. Type of cross sections. The type of cross section we want to use strongly depends on the data available. There are various types of cross sections available and different data input is required for different type of cross sections. Types of cross sections available in Sobek are trapezium, round, egg-shape, tabulated, rectangle, Y-Z profile, elliptical, arch, cunette and steel cunette type. In this case, trapezium type of cross section is used as we have very little knowledge of the shapes in the river. In this type of cross section, values for bottom width, embankment slopes and maximum flow are sufficient.
2. Bed level values, to represent the bed level of the cross section. However, the value here does not always represent the bed level, depending on the type of cross sections we want to use based on the available data. Usually, this bed level value is needed when trapezium type of cross section is used, like the case in this research.
3. Surface level, to represent the level of embankments at this cross section. Note that in the hydrodynamics calculations the value that is filled for surface level is not being used. For this calculation, Sobek uses the entire cross section definition.

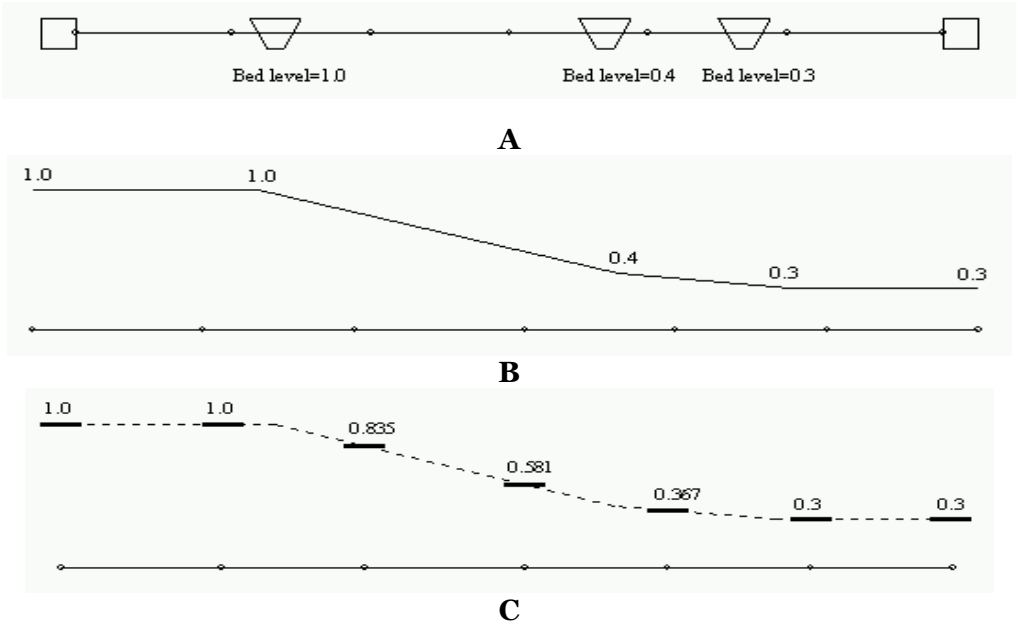


Figure 3-16 Principle of interpolation and extrapolation of the river cross section A) Input data of bed levels in a reach, B) resulting linear interpolation and constant extrapolation C) Resulting discrete interpolation and extrapolation

3.3.3. Input boundary condition in SOBEK

Nowadays there is a tendency towards integrated Modelling through the coupling of various processes, such as surface water flow, ground water flow, rainfall-runoff processes, water quality, etc (WL-DELFT_HYDRAULIC, 2003). In terms of model coupling, there are ways in which model may be coupled, in case time dependent processes are simulated:

1. Sequential coupling. In this scenario, one model is executed first and another model uses the model results as boundary conditions or extracts parameter values
2. Parallel coupling with exchange at every time step. Usually a limited number of dependent variables are exchanged at one or a number of locations in the model.
3. Parallel coupling with exchange at pre-defined intervals or at intervals subject to certain conditions. In principle, this implies the second case
4. Parallel coupling with memory sharing enabling the joint executions of solution algorithms. Whereas the first three cases refer to an explicit coupling, this case allows for the implicit solution of equations generated by both models.

This study will apply the principle of the first case of model coupling, where the results of a previously conducted model are used as input for this study. The input of the model are the results of a study by NIPPON KOEI Consultant that modelled the whole Bicol basin using MIKE 11 (BCEOM Consultants, 1991). The output of the MIKE 11 model are discharge hydrographs at the upstream boundaries of this study for flood events of the

return periods of 1.25 years, 5, 10 and 25 years. The downstream boundary condition for this study is the water level due to tidal fluctuation of the San Miguel bay. Values for return period of 2 and 50 years are derived from interpolation and extrapolation of the Nippon KOEI data.

In the schematisation, there are four boundary nodes: three 1D nodes (up stream boundaries of the Bicol, Naga and Libmanan River) and one 2D Node, the sea level at San Miguel Bay (see Figure 3-17). The input data at those nodes vary, depending on the return period of the simulated flood.

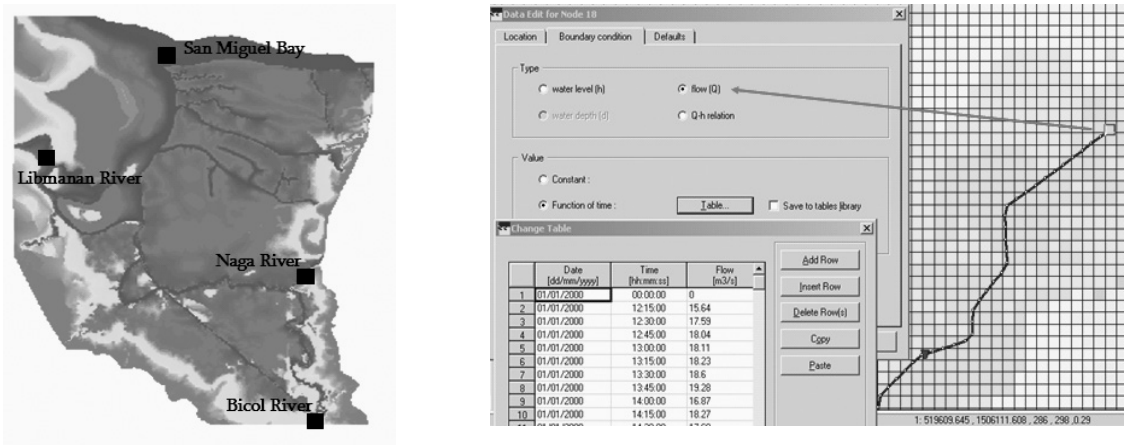


Figure 3-17 The four boundary nodes and input screen of boundary nodes in SOBEK

Those four boundaries use hydrographs as seen in the Figures 3-18 to 3-21. The complete discharge and water level boundaries were attached in appendix 10-7 to 10-11.

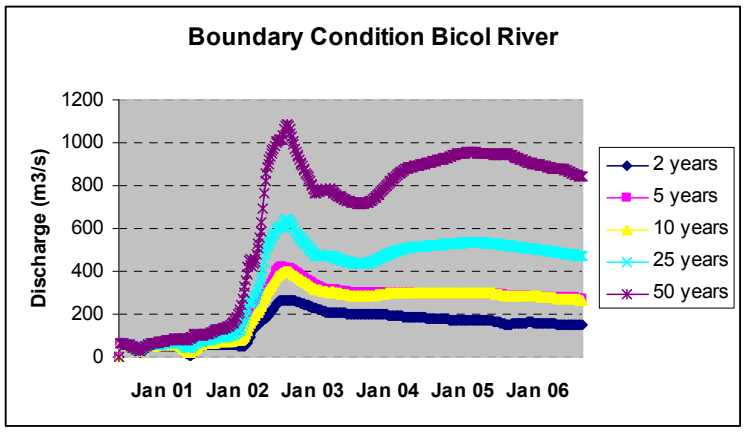


Figure 3-18 Input hydrograph at Bicol River boundary for different return period

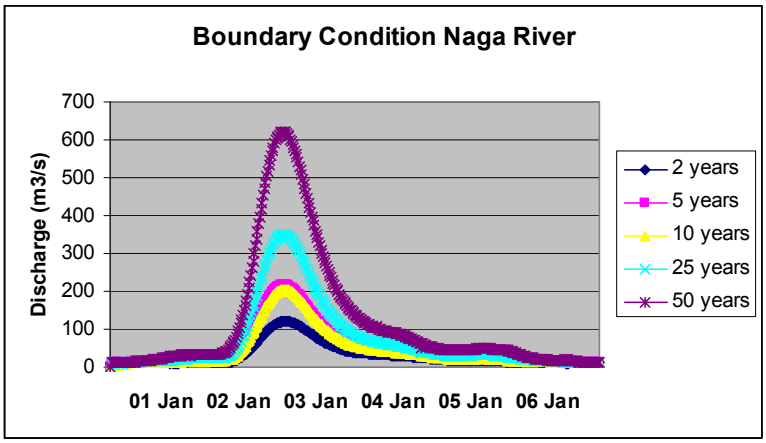


Figure 3-19 Input hydrograph at Naga River boundary for different return period

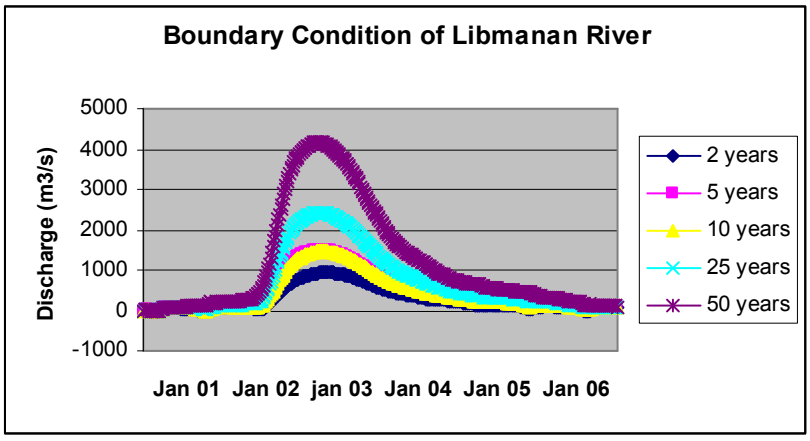


Figure 3-20 Input hydrograph at Libmanan River for different return period

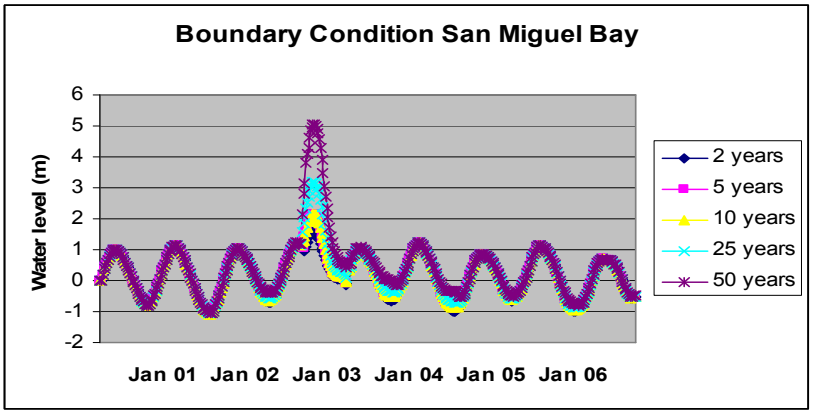


Figure 3-21 Input hydrograph at San Miguel Bay for different return period

3.4. Model Output

SOBEK is capable of producing several output files at specified intervals in the 'output-parameter' of the model setting section. The following parameters can be obtained:

Discharge at sections – showing discharge through particular sections; the result is a hydrograph on that section.

History stations – It is a user-defined node where fluctuations of the simulated water level are registered. The result is a time series of the water level for that particular node.

Restart Interval – It is created by default at the end of each successful model run. However, time interval can be pre-specified when it is required to create a restart file during the simulation. Then, each pre specified time intervals restart file will be created and overwritten previous restart file that had been created. The restart file can be used for the next simulation if the computation fails before ending the complete simulation or as start condition for a follow-up simulation.

Quantitatives in map files – This allows the pre-selection of the map files to be saved during the simulation, i.e. water depth (H), flow velocity (C), water level (Z) and velocity components (u,v).

Maximum quantities in map files – In addition to the selection of required map files at simulation time steps, it is further possible to generate files having maximum quantities of each output parameter at pixel level. For example, if it is specified to create the maximum flow velocity file, the program will create a raster file containing the maximum flow velocities in each pixel during the simulation period. This output file is useful to create flood hazard map

Video animation using incremental water depth or velocity

4. Analysis of Flood Events in the Lower Bicol Floodplain

4.1. Introduction

This research applies a 1D2D hydrological model to simulate some design floods in the Lower Bicol Floodplain. A design flood is defined by its probability of occurrence. It represents a flood that has a particular probability of occurring in any one year. For example, the 1% AEP (Annual Exceedance Probability) or 1 in 100 ARI (Average Recurrence Interval) flood is a best estimate of a flood which has 1 chance in 100 of occurring in any one year. It is important to acknowledge that the 100 year ARI event may occur more than once in a 100 year period as the definition of the event is that it occurs once, on average, in 100 years. Therefore, planning for the 1 in 100 year ARI flood does not guarantee protection for the next 100 years. Similarly, the 100 year ARI event may not occur at all within a 100 year period for the same reason. In this research, floods with average recurrence of interval of 2 year, 5 year, 10 year, 25 year and 50 year were simulated, analyzed and compared.

Often the term *return period* (sometimes called *recurrence interval*) is used rather than exceedance probability. For example, the annual maximum flood flow exceeded with a 1 percent probability in any year, or chance of 1 in 100, is called the 100-year flood. In general, x_p is the T-year flood for

$$T = 1 / (1-p)$$

Equation 4-1

Return period is a means of expressing the exceedance probability. It is often spoken the 20-year flood or the 1000-year rainfall, rather than events exceeded with probabilities of 5 or 0.1 percent in any year, corresponding to chances of 1 in 20, or 1 in 1000. Sometimes the term return period has been incorrectly understood to mean that one and only one T-year event should occur every T-year. Actually, the probability of the T-year flood being exceeded is $1/T$ in every year. Thus, the 1 percent exceedance event can be described as a value with a 1 in 100 chance of being exceeded each year (Maidment, 2000). For instance, 100 years return period is a probabilistic assessment that means a given event has a one-in-one hundred chance (1 percent) of occurrence in any given year, or a "return period" of once every 100 years. Such assessments are based upon statistical frequency of collected data. The 100 year return period storm has a 9.6% chance of occurrence in 10 years, 22% chance in 25 years, 39% chance in 50 years and an 86% chance in 100 years. In other words, probability of a flood event

occurring is expressed as a percent chance that a flood of a specific magnitude will occur in any given year. For example, a flood with a 10-year recurrence rate has a 10 percent chance of occurring in any one year. For other return periods, the probability can be seen in Table 4-1.

Table 4-1 Chances of occurrence of different return period of floods

Flood Return Periods	Chance of Occurrence In Any Given Year
2 years	50 %
5 years	20 %
10 years	10 %
25 years	4 %
50 years	2 %
100 years	0.1 %
500 years	0.2 %

4.2. Analysis of flood events with different return periods

The model simulations were carried out for 2, 5, 10, 25 and 50 years return period of floods with 6 days of simulation time. With one hour interval, there were 120 ASCII raster water depths, water level and velocity files were obtained from each simulation. Those files were converted into GIS-ILWIS system to be able to do post simulation analysis to obtain flood indicator maps. The results of each simulation for each return period were analyzed to see the different flood behaviours of different flood events.

Analysis of flood events is done by comparing the different output of the model for different return period of floods. Comparison is made based on the spatial extent, water depth, flow velocity and warning time as different return periods of floods have different behaviours of those flood characteristics.

4.3. Comparison of 2, 5, 10, 25, and 50 year floods

4.3.1. Spatial Extent

Spatial extent is defined by the total area which is inundated. Hence, it contains the land-water boundary showing the extent of a flood in a floodplain. Based on the modelling results, it was found that the there is a correlation between flood extent and return period of floods, where the smaller probability of one flood event to occur, the more areas to be inundated. Comparison of flood extent for different return period can be seen in Figure 4-1. Figure 4-2 shows the comparison of total areas which are flooded and not flooded for different return period of floods.

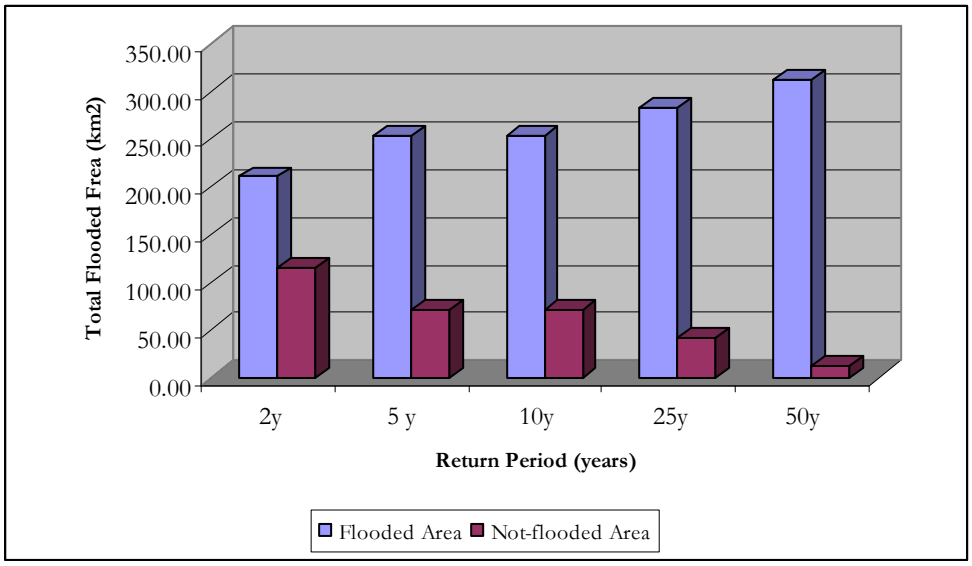


Figure 4-1 Percentage of flood extent for return period of 2,5,10,25, and 50 years.

The model showed that there is a big difference in the flood extent from the most probable flood happen in a year to the least probable flood, i.e. from return period of 2 years to return period of 50 years. The slightest change occurred in the flood with 5 and 10 year return periods, where there is only one percent difference in terms of flood extent. The slight difference in the flood extent may be explained as due to the low elevation of the floodplain in the study area. In addition, the DEM used for this modelling was limited to the maximum of 5-meter height.

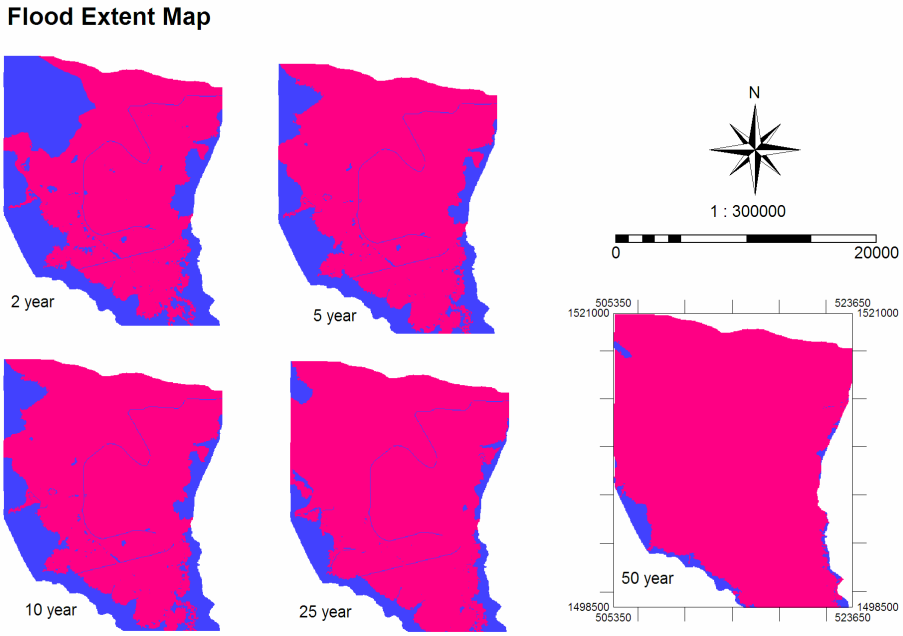


Figure 4-2 Flood Extent Map for return period of 2, 5, 10, 25, and 50 years.

The model also shows that there is an increase of flooded areas at the less probability of flood events to occur. Figure 4-3 shows that an increase of flooded areas from 21 km² at the return period of two years to around 31.5 km² of flooded areas at return period of 50 years. Interestingly, it can be seen that there is no pattern of the increase of flooded areas as the less probable of floods occur. For instance, if for return period of 5 years there are 20 km² areas flooded; it does not mean that there will be (5x20) km² areas flooded for return period of 10 years.

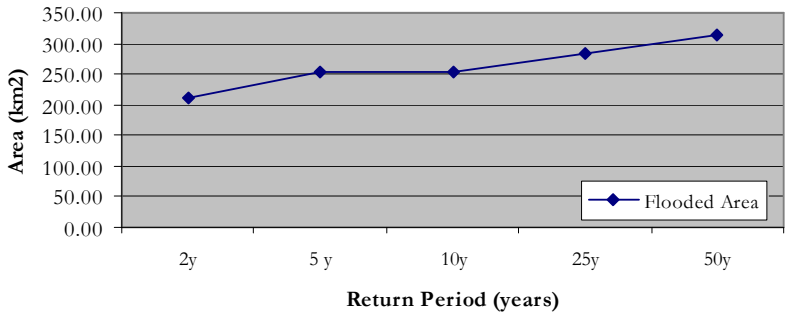


Figure 4-3 Comparison of total flooded area for different return periods

4.3.2. Inundation depth

With the less probable floods to occur, the inundation depth was deeper in the floodplain. Consequently, maximum depth of inundation was also increased in the smaller probability of floods to occur. Comparison between maximum depth of inundation for different return period of floods can be seen in Figure 4-4.

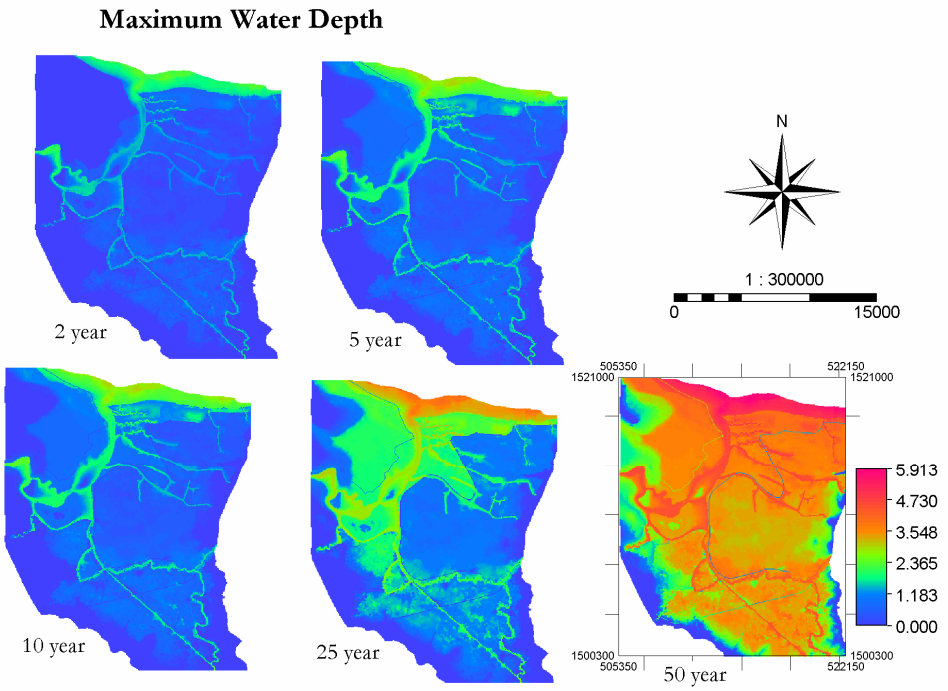


Figure 4-4 Spatial distribution of water depths at peak-flow conditions for 2-, 5-, 10-, 25-, and 50-year return period of floods.

The most extreme depth of water occurs in the flood with return period of 50 years, where there were 175 km² areas with water depth was between 3 to 4 meters. Maximum depth which is about 6 meter only occurs in this event (see Figure 4-5).

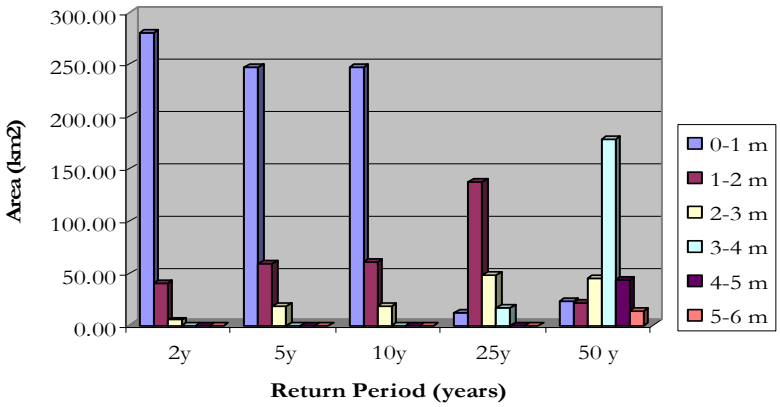


Figure 4-5 Percentage of water depth for return period of 2, 5, 10, 25, and 50 years.

During the 2-year flood, peak water depths exceeding 2.5 meter were restricted to the main channels. The main secondary channels near the San Miguel Bay had peak water depths of 1.5 to 1.8 meter. Water depth exceeded in the large amount in the 25 and 50 year return periods. During the 25 year peak, water depths were greater than 1.3 meter over the floodplain, and water depths in the deepest area of the main channels exceeded 3.5 meter in depth. The highest water depth in the floodplain occurs on the floodplain between Bicol River and Cut-off channels at the southern part of the area and at the northern part of the Libmanan River. This area reaches almost 2 meter depth and increases up to 2.4 meter near the bay. This is caused by the big discharge of Libmanan River and the influence of the tidal fluctuations from the San Miguel Bay.

Results at some history stations in the model also show that the water reaches its peak flow at the 60th hour and continuously decreased until the fifth day of simulation (see Figure 3-13 for location of history stations). The wetting system in the model was not defined thus after five days of simulations; it was obtained in the results that the water in the floodplains still remained. It varies from zero meters in the return period of 2 year to 70 cm for return period of 50 years (Figure 4-6)

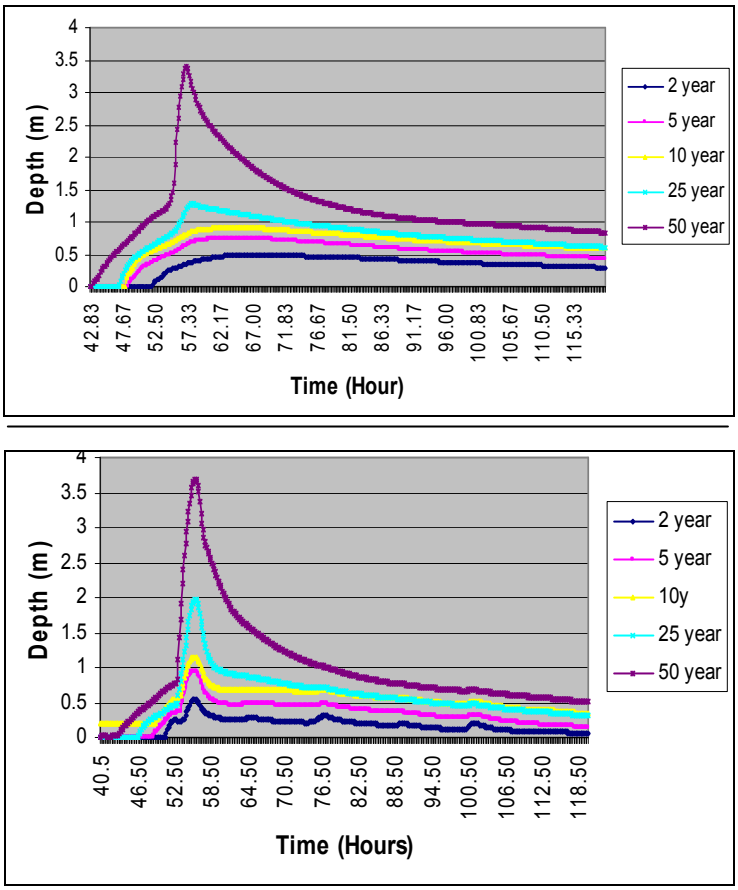


Figure 4-6 Water depth at history stations 56 (upper) and 65 (below) for return period of 2, 5, 10, 25, and 50 years

4.3.3. Velocities

Graphs of the dynamic simulations indicate the temporal variability of the flow velocities in main channel and at the inundated areas when water stream flow inundates the floodplain. Maximum simulated velocities decreased from large flood to small flood to occur. Maximum flow velocity at some points in the area was 1.58 m/s in the return period of 2 years to reach 3.47 m/s and 4.84 m/s in the return period of 25 and 50 years. However, for the return period of 5 and 10 years, maximum velocities have slight differences, about 2.35 m/s. The difference can be observed on the floodplain, where velocity in the return period of 5 years was slightly lower than that of 10 years return period.

In general, high velocities occurred in the straight channels in the estuary where the maximum velocities for return periods of 25 and 50 years occurred there. It was analyzed to be due to the high discharge coming from Libmanan and Bicol River and influence of the highest tidal fluctuation from San Miguel Bay. After analyzing the time to reach maximum velocity, it was found that maximum flow velocities coincided with highest level of fluctuation in San Miguel Bay. Velocity conditions during peak

stage/stream flow for each of the 2-, 5-, 10-, 25-, and 50-year return period of floods are shown in Figure 4-7.

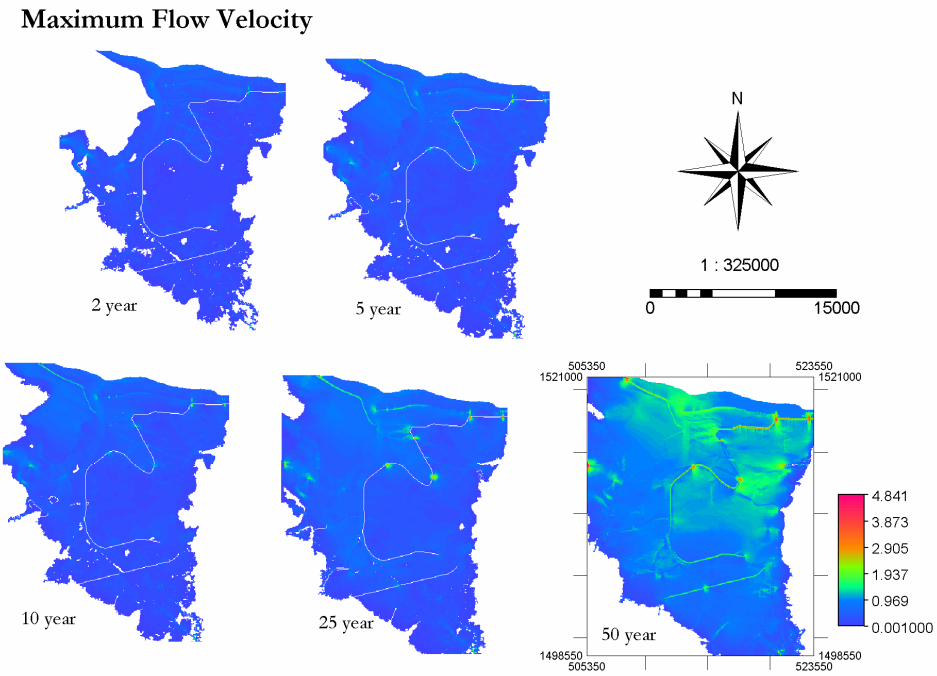


Figure 4-7 Spatial distribution of velocities at peak-flow conditions for 2-, 5-, 10-, 25-, and 50-year return period of floods.

In Figure 4-8, it can be observed that in the second half of the flood event, the velocities for all return periods at each flood event remained stable only decreased at small points, as seen in Figure 4-8. It is assumed that if the simulations had been made longer, we could see the time when the velocities reached 0 m/s. For return period of 50 years, the time to get velocity 0 m/s was predicted to be longer than other flood events.

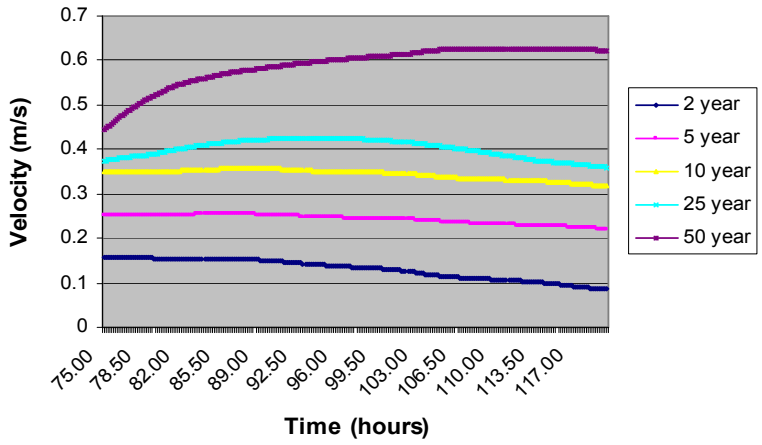


Figure 4-8 Flow velocities at the last 40 hours at history station 60 for return period of 2, 5, 10, 25, and 50 years

4.3.4. Impulse

Maximum impulse signifies the amount of water movement through the area during the flooding event. In the other words, maximum impulse is the quantity of moving water. It is obtained from the integration of water depth and flow velocity maps by multiplying both maps. The maximum impulse maps for different return period can be seen in Figure 4-9.

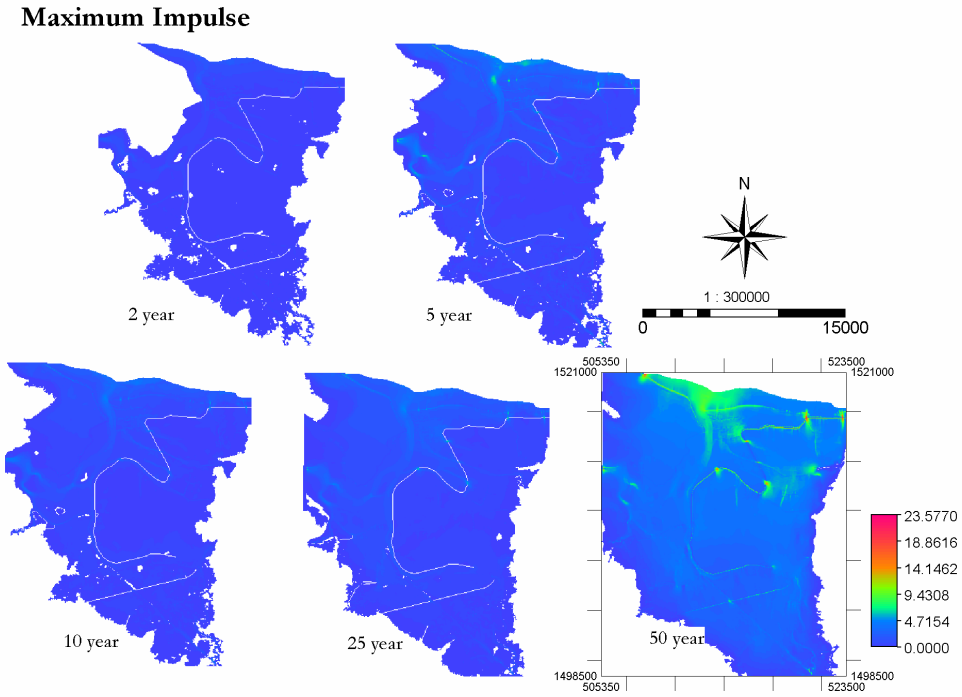


Figure 4-9 Spatial distribution of maximum impulse at peak-flow conditions for 2-, 5-, 10-, 25-, and 50-year return period of floods.

4.3.5. Warning Time

Warning time maps shows how much time is needed by the people before the flood reaches their home. The results of the simulation show that the bigger return period of floods, the less warning time for the people until the water reaches their house. The percentages of average warning time for different return periods, show that there was more warning time at the return period of 2 years and decreases at the return period of 5, 10, 25 and 50 years. The most significant difference occurred at return period of 50 years, where the maximum warning time was 6 hour (see Figure 4-10). Figure 4-11 shows spatial distribution of warning time before the water reaches the area.

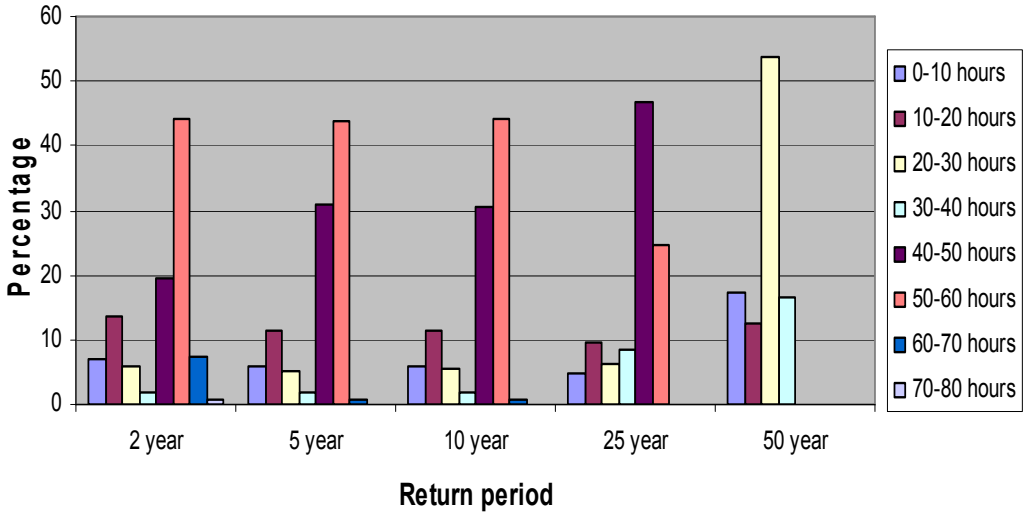


Figure 4-10 Percentage of warning time for return period of 2, 5, 10, 25, and 50 years.

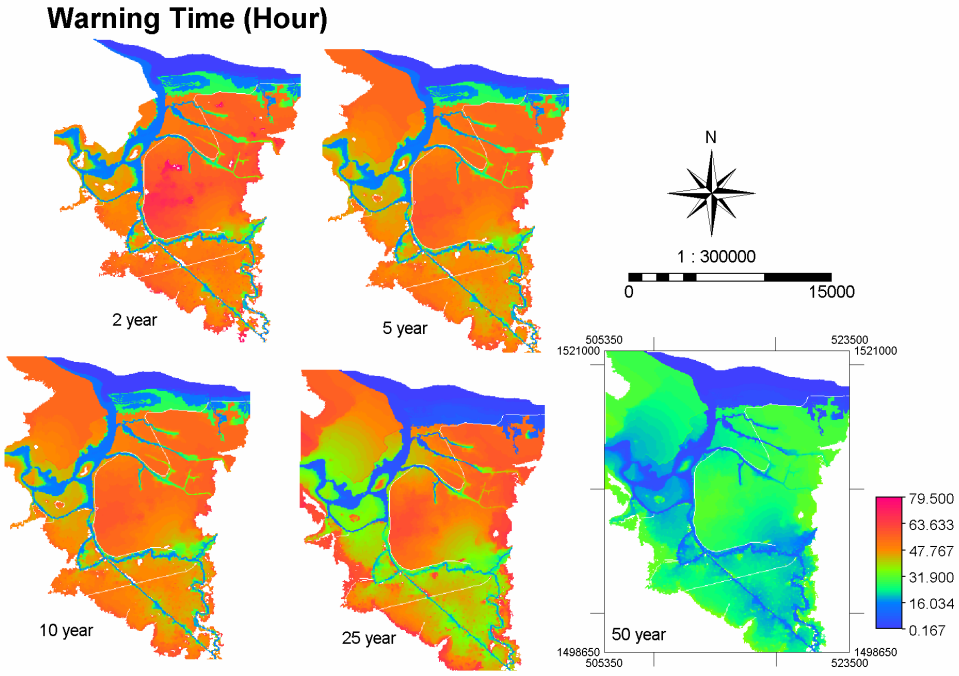


Figure 4-11 Warning Time Map for return period of 2, 5, 10, 25, and 50 years.

5. Model Validation and Calibration

5.1. Validation of the inundation extent

Since no measured flood data available in the whole Bicol Basin, the simulation results for return periods of 5, 10, and 25 years were compared with existing flood extent map for the same return periods. Those existing maps were available from the model developed by NIPPON KOEI in 2003 from Bicol River Basin and Watershed Management Program. The model had been used to test a range of model scenarios for the purpose of flood alleviation and also for other management works for the Bicol basin (Nippon KOEI CO, 2003).

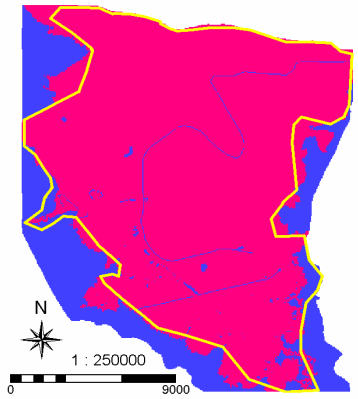
Comparison between model result and the model reference developed by Nippon Koei in percentage and in surface area which are flooded and not flooded can be seen in Table 5-1.

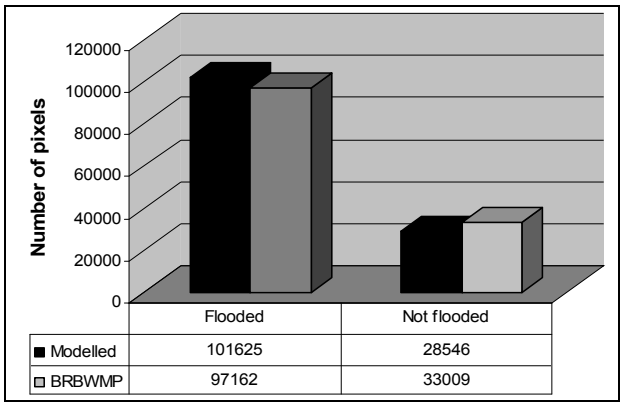
Table 5-1 Comparison between model result and model developed by Nippon Koei in BRBWMP

		Percentage (%)			Surface Area (km²)		
		5 year	**10 year**	**25 year**	**5 year**	**10 year**	**25 year**
	BRBWMP, 2003	74.64	78.10	91.31	228.41	242.91	297.14
Flooded	**Modelled**	70.19	78.08	87.05	254.06	254.16	283.28
	BRBWMP, 2003	25.36	21.90	8.69	82.52	97.02	28.29
Not flooded	**Modelled**	29.81	21.92	12.95	71.37	71.27	42.15
Difference		**3.44**	**7.91**	**4.26**	**11.16**	**25.75**	**13.86**
					Total area = 324.96 km²		

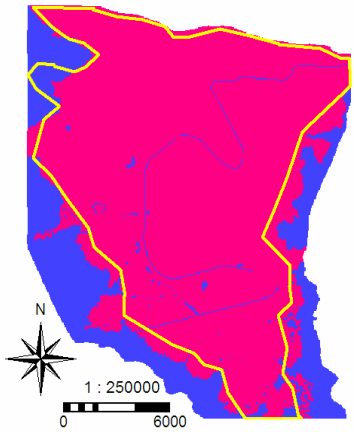
Inundation extent obtained from the model simulation shows that there was less than 8 percent difference (over estimate) between the result of the model and the model developed by Nippon Koei in Bicol River Basin and Watershed Management Program. The biggest difference was occurred at 10-year return period at 7.91 percent. Other results have difference at only 3.44 percent (5 year return period) and 4.26 (10 year return period). Comparison of inundation extent between the model result and model of Nippon Koei in Bicol River Basin and Watershed Management Program can be seen in Figure 5-1.

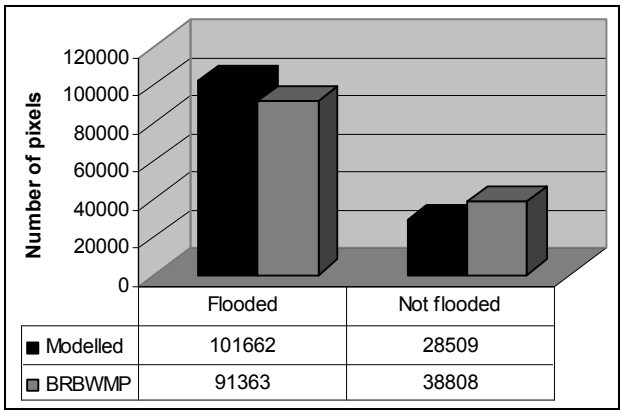
5 year return period



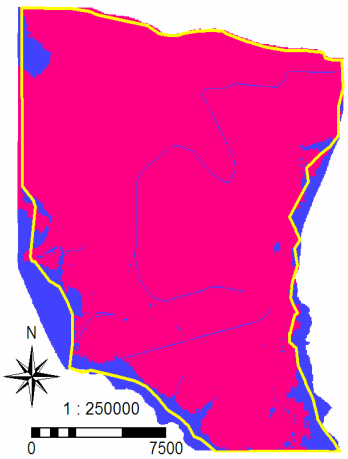


10 year return period





25 year return period



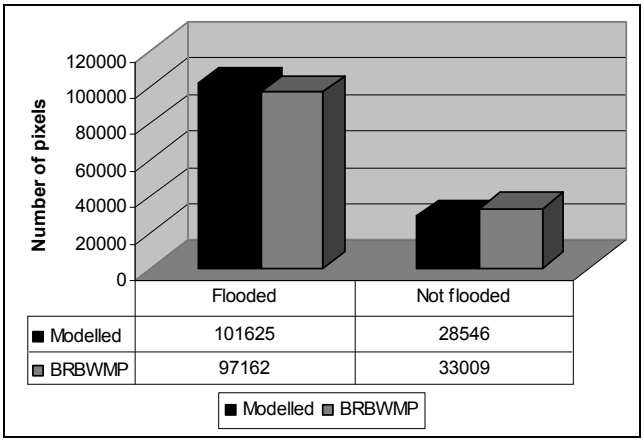


Figure 5-1 Model result of flood extent for return period of 5 years (top), 10 years (middle), and 25 years (bottom) in comparison with Nippon Koei Model in BRBWMP, 2003. Yellow line shows the maximum extent of the Nippon Koei model, flooded areas shown in red.

5.2. Calibration of the Water Level Model

Since there is no real measurement data, the maximum water level of the model result was validated with maximum water level at some sub basins from the 2003 model from Bicol River Basin and Watershed Management Program. The model had been used to test a range of model scenarios for the purpose of flood alleviation (Nippon KOEI CO, 2003). The validated maximum water level at some sub basins can be seen in Table 5-2, Table 5-3 and Table 5-4.

Table 5-2 Calibration of water level model at some sub-basins for return period of 5 years

	Water Level (m+a.s.l)		
Sub Basin	**BRBWMP**	**Modelled**	**Difference**
Pamplona	2.29	2.52	-0.23
Cabusao	2.19	2.2	-0.01
Canaman	2.03	2.18	-0.15
San Fernando	1.97	1.9	0.07
Balongay	1.32	1.29	0.03
Libmanan	0.76	0.65	0.11

Table 5-3 Calibration of water level model at some sub-basins for return period of 10 years

	Water Level (m+a.s.l)		
Sub Basin	**BRBWMP**	**modelled**	**Difference**
Pamplona	2.91	2.83	0.08
Cabusao	2.84	2.74	0.1
Canaman	2.55	2.63	-0.08
San Fernando	2.51	2.56	-0.05
Balongay	1.66	1.75	-0.09
Libmanan	0.97	1.1	-0.13

Table 5-4 Calibration of water level model at some sub-basins for return period of 25 years

	Water Level (m+a.s.l)		
Sub Basin	**BRBWMP**	**modelled**	**Difference**
Pamplona	3.69	3.54	0.15
Cabusao	3.66	3.82	-0.16
Canaman	3.21	3.3	-0.09
San Fernando	3.19	3	0.19
Balongay	2.1	1.9	0.2
Libmanan	1.25	1.19	0.06

Location of the sub basins where water level is calibrated can be seen in Figure 5-2. Graphical comparison can be seen in Figure 5-3, Figure 5-4 and Figure 5-5.

Figure 5-2 Location of sub basins where water level is calibrated (source: BRBFCIDP, 1991)

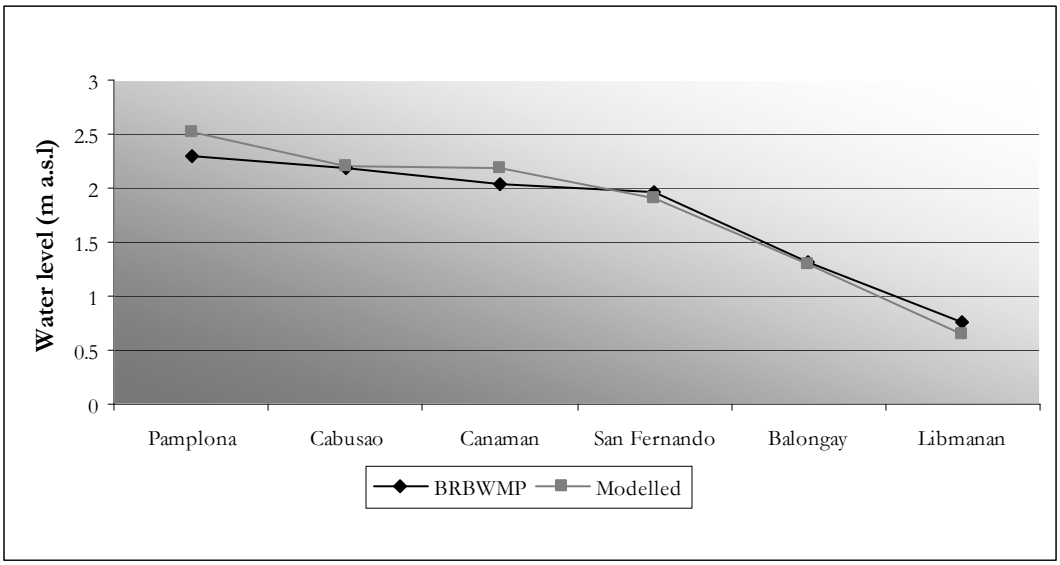


Figure 5-3 Graphical comparison of maximum water level at some sub basins for return period of 5 years

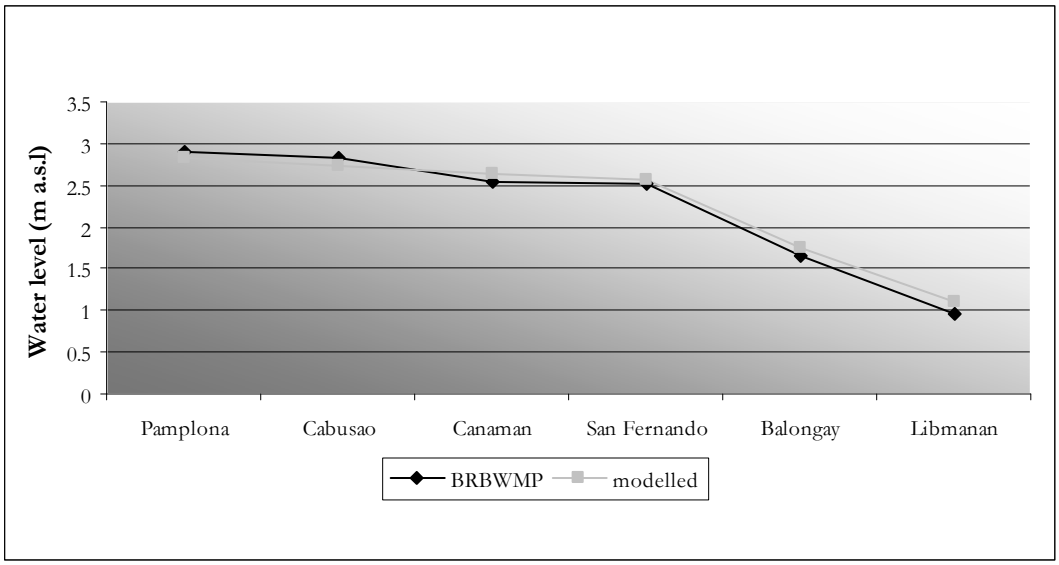


Figure 5-4 Graphical comparison of maximum water level at some sub basins for return period of 10 years

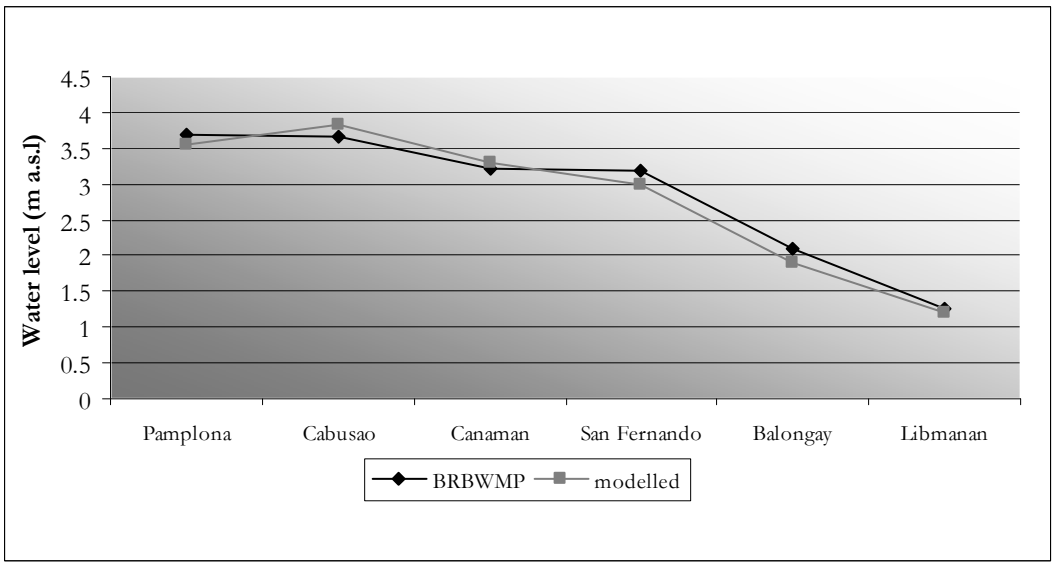


Figure 5-5 Graphical comparison of maximum water level at some sub basins for return period of 25 years

Overall, good agreement between model result and hydraulic model from Bicol River Basin and Water Management Program was obtained for the calibration events. However, it should be noted that not all areas are calibrated due to the unavailability of calibrating data.

6. Flood Hazard Mapping

6.1. Introduction

Hazard maps have been recognized as instruments for disaster management in many countries in recent years. Flood hazard mapping is used to determine the areas susceptible to flooding when discharge of a stream exceeds the bank-full stage. It is usually based on the following sets of information:

- Historical flood events.
- Damage reports.
- On-site observations verified by local residents and Civil Defence personnel.
- River modelling works (computer programmes that predict how a river behaves under certain conditions - particularly where information is scarce).
- Survey work that determines peak flood heights and an assessment of the flood extent after each event.

In this chapter, the characteristics of flood hazard maps for different return period of floods are described which are obtained from the river modelling results.

6.2. Flood Hazard Categorization

6.2.1. Single Parameter Categorization

Conventionally, flood hazard map is produced based on one parameter. In many cases, it is made based on the depth of inundation by classifying the depth of inundation. However, with the development of 2D hydrodynamic models for riverine flood simulation, it is possible to create flood hazard maps by incorporating additional hazard parameters. Moreover, 2D model results provide further opportunity to develop more meaningful hazard maps by incorporating additional hazard parameters. This study attempts to identify potentially hazardous areas threatened by flood effects based not only by single parameter, e.g. depth of inundation or flow velocity, but also integration of more than one parameter, which will further be explained in Chapter 6.2.2.

6.2.1.1. Depth of inundation

At the end of flood simulation, SOBEK creates a depth of inundation file at every specified time step and a final maximum water depth file. Therefore, after having

converted the output maximum water depth map into raster format, flood hazard map based on inundation depth can be obtained. To generate classes of hazard map, the maximum water depth shall be classified in the GIS system.

Classes parameter of hazard maps based on inundation depth are defined in Table 6-1. It shows depth classes defined for determining the classes of hazard for different return periods.

Table 6-1 Classes parameter for determination of flood hazard classes on inundation depth

Hazard Class	Maximum water depth (m)
High Hazard	5
Medium Hazard	2.5
Low Hazard	1
No Hazard	0

Based on that table, flood hazard map with inundation depth parameter are created at different return periods (Figure 6-1). Percentage comparison of classes of hazard can be seen in Figure 6-2 and Table 6-2.

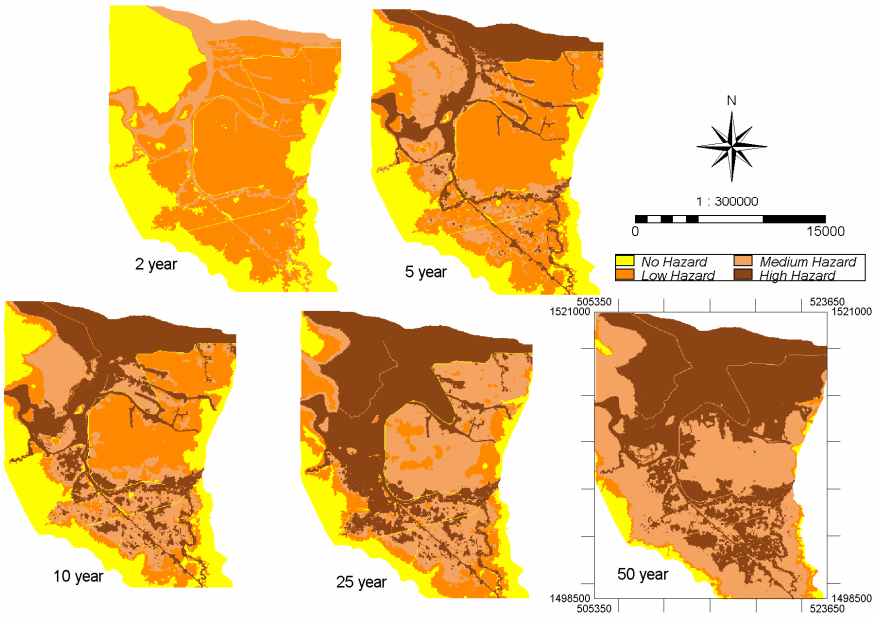


Figure 6-1 Flood Hazard Map based on depth of inundation

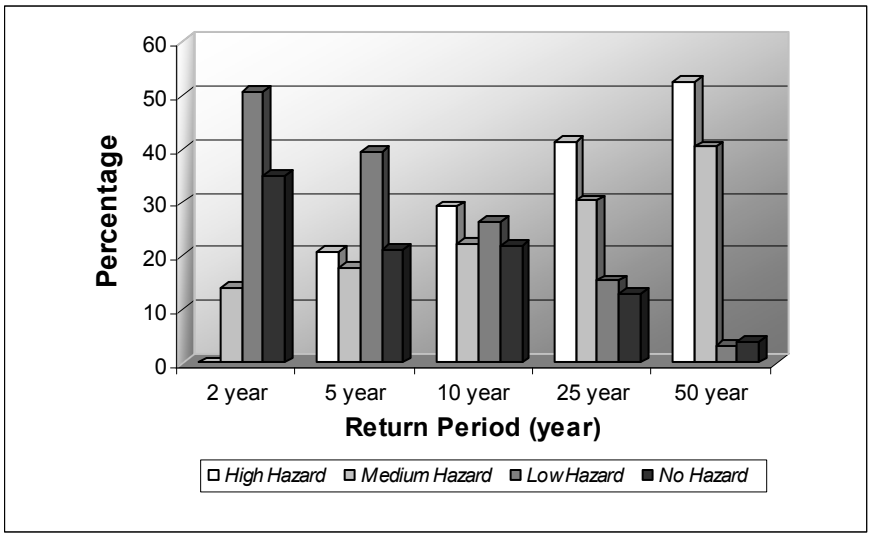


Figure 6-2 Percentage comparison of hazard classes based on inundation depth

Table 6-2 Percentage of hazard classes based on inundation depth

Hazard Class	2 year	5 year	10 year	25 year	50 year
High Hazard	0	20.85	29.22	41.43	52.58
Medium Hazard	13.97	17.91	22.44	30.39	40.47
Low Hazard	50.85	39.42	26.33	15.34	3.12
No Hazard	35.18	21.28	22.01	12.83	3.83

6.2.1.2. Flow Velocity

Flow velocity is also important parameter for flood risk assessment. It has been widely performed for damage assessment. Flow velocity maps obtained from the result of modelling were classified into four hazard classes in the GIS system based on the parameters in Table 6-3.

Table 6-3 Classes parameter for determination flood hazard classes on flow velocity

Hazard Class	Maximum flow velocity (m/s)
High Hazard	1.5
Medium Hazard	0.7
Low Hazard	0.3
No Hazard	0

To compare hazard maps based on velocity for different return periods, classes of hazard maps were made based on the parameters in Table 6-3. Hazard maps based on the flow velocity are shown in Figure 6-3.

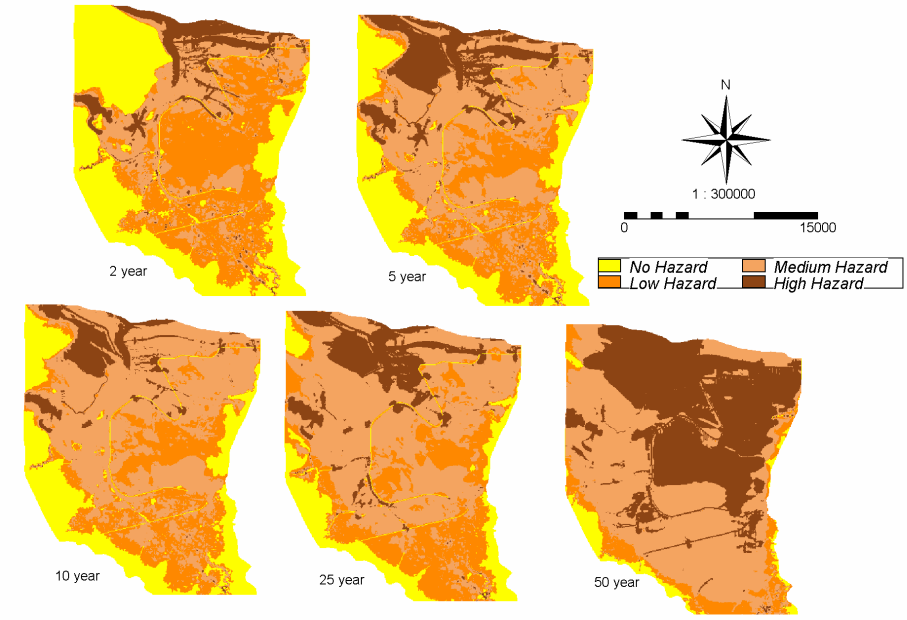


Figure 6-3 Flood Hazard Map based on flow velocity

To see the difference of hazard classes for different return periods based on flow velocity, comparison in table and graphic are provided in Table 6-4 and Figure 6-4.

Table 6-4 Percentage of hazard classes based on flow velocity

Hazard Class	2 year	5 year	10 year	25 year	50 year
High Hazard	8.91	14.77	7.87	12.97	42.44
Medium Hazard	22.42	41.23	48.19	49.22	45.97
Low Hazard	33.41	22.08	22.04	24.87	7.62
No Hazard	35.26	21.93	21.9	12.94	3.96

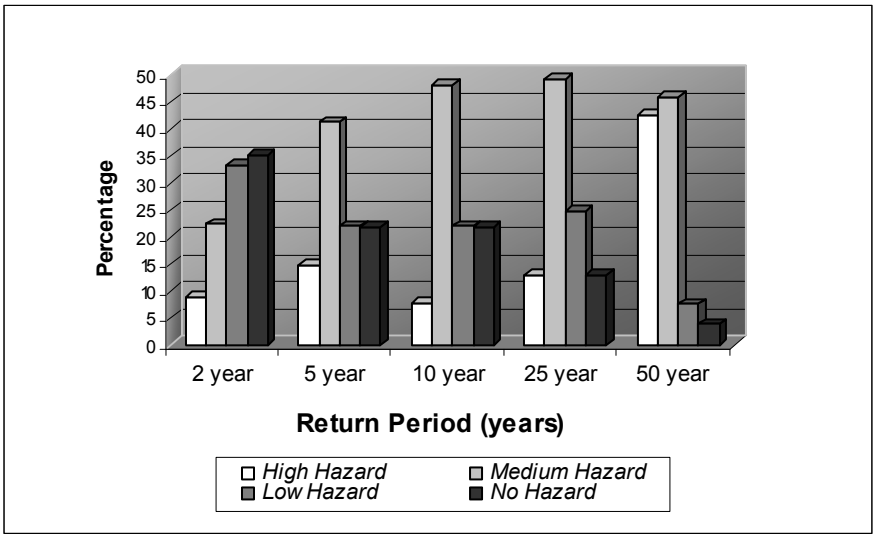


Figure 6-4 Percentage comparison of hazard classes based on flow velocity

6.2.1.3. Warning Time

To lessen the impact of flood disasters on people and property, mitigation is done as the basic of emergency management. Mitigation can be done by developing good warning time system. There are indeed two methods of flood mitigation: structural (e.g. dams and dike) and non-structural methods. Among non-structural methods, modern flood forecasting and real-time data collection systems have grown favour in countries prone to flood hazards (Aziz, 2002). Warning time is a further step after the flood forecasting to inform people about the time when flood comes, according to the forecasting.

Warning-time flood hazard map is made based on the time when flood first occurred in each pixel. It is assumed that people need to be prepared once the flood comes to their houses. Warning time maps was created based on the pre-defined classes parameters shown in Table 6-5.

Table 6-5 Classes parameter for determination flood hazard classes based on warning time

Hazard Class	Warning Time (hours)
High Hazard	20
Medium Hazard	50
Low Hazard	80
No Hazard	00

Thus, based on the classes' parameters in Table 6-5, the time when the flood occurs was classified to define the flood hazard map, as seen in Figure 6-5.

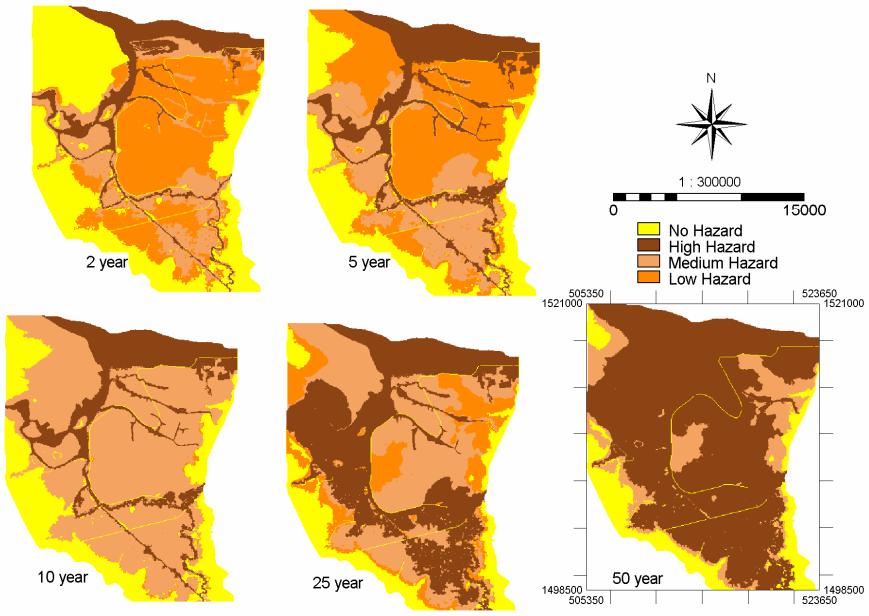


Figure 6-5 Flood Hazard Map based on warning time map

It is derived from the modelling result that classes of high hazard is increased from the bigger to less probability of flood to occur. Figure 6-6 shows that for return period of 50

years, class of hazard was dominated with high hazard, while for return period of 2 years where the most probability of flood to occur every year, it is dominated with low class of flood hazard.

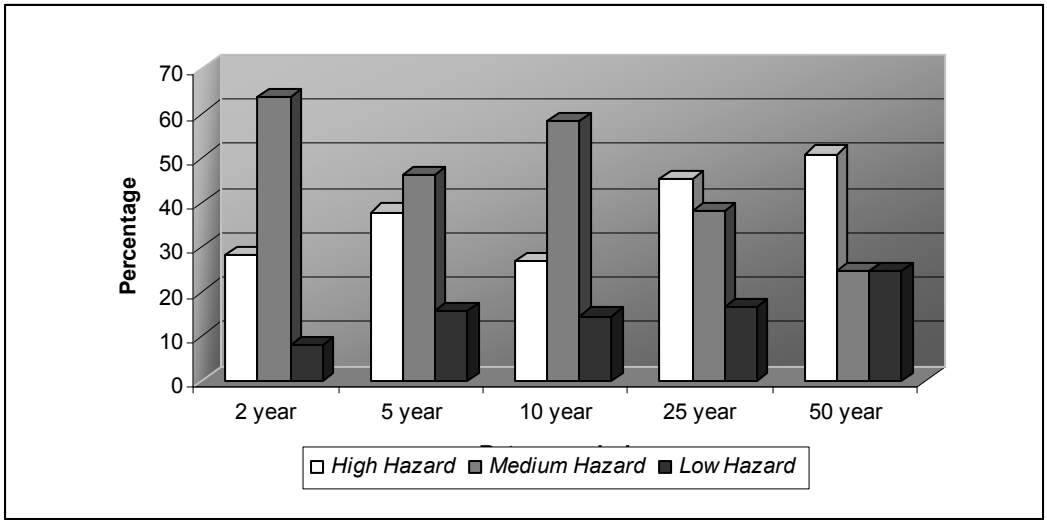


Figure 6-6 Percentage comparison of hazard classes based on warning time

6.2.2. Multiple parameter categorization

Nowadays, there is a tendency to incorporate more than one hazard parameter to create flood hazard map, which later called as multiple parameters. A number of experts had done such incorporations, such us Gendreau (1998) combines inundation depth, duration and maximum acceptable return period, Abt et al. (1989), Temez (1992) and Penning-Rowsell & Tunstall (1996) propose combinations of flow velocity and inundation depth to distinguish hazardous and non-hazardous floods. The RIPARIUS project proposes a hazard and risk matrix in which hazard categories are defined by flow velocity, inundation depth, flood warning time and annual probability of flooding. In this chapter, it is shown the combination of some hazard parameters to create flood hazard map.

6.2.2.1. Velocity vs. Depth of inundation

Combination of velocity and depth of inundation is adapted from a concept of Penning-Rowsell & Tunstall (1996). They define the flood hazard maps with two parameters of which the values are based on the diagram in Figure 6-7. Based on the diagram, flood hazard map with parameters of inundation depth and flow velocity are created at different return periods (Figure 6-8).

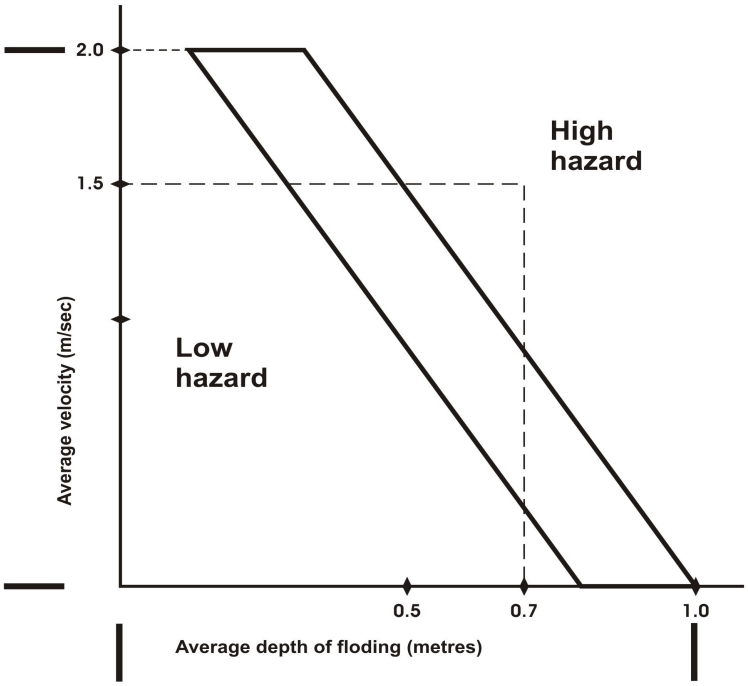


Figure 6-7 The categorization of flood hazard based on velocity and water depth (Penning-Rowsell & Tunstall, 1996)

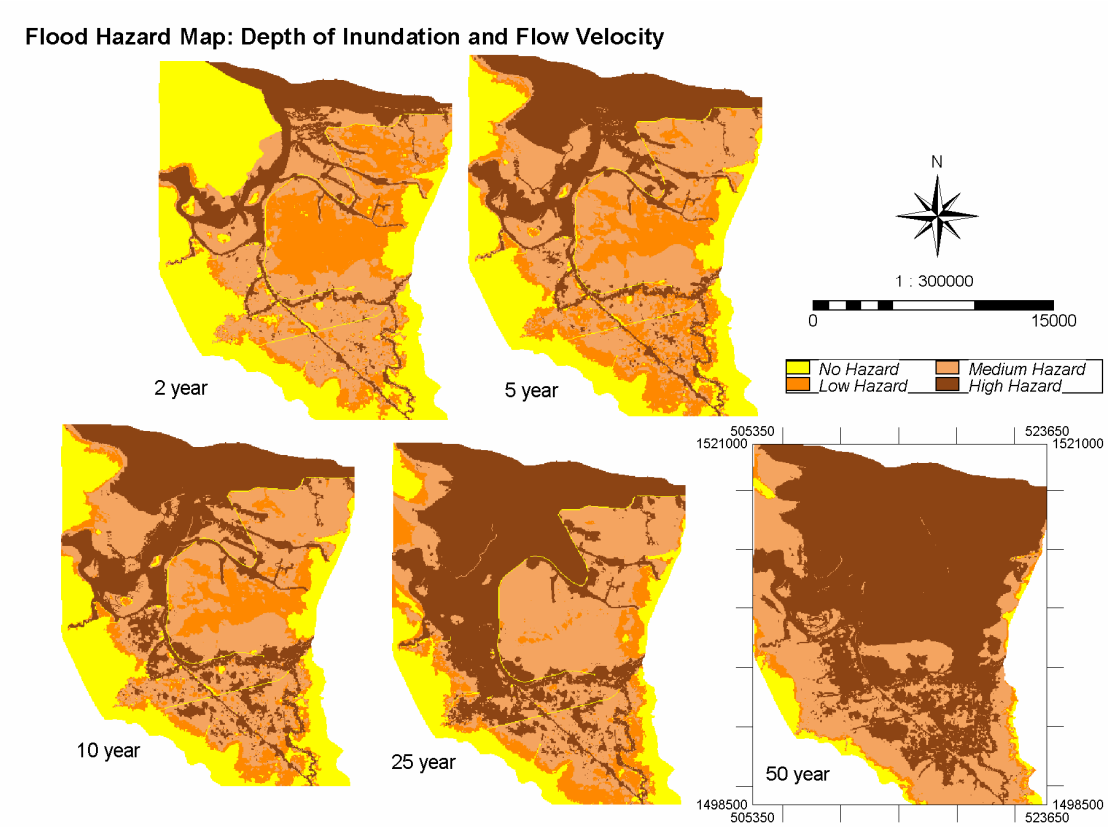


Figure 6-8 Flood Hazard map: combination of water depth and flow velocity

6.2.2.2. Velocity, Depth of inundation and Warning time

In the final combination, the three parameters (flow velocity, depth of inundation and warning time) were classified into three categories: Low, medium and High hazard as shown in Figure 6-9 below. The classification was done following an exclusive criterion. Iff all three individual maps are represented as low hazard, and then those areas were classified as low. If at least one map represents medium while others are low, then those areas were classified as medium. Finally, if in at least one individual map the area is represented high hazard, then those areas were classified as high hazard.

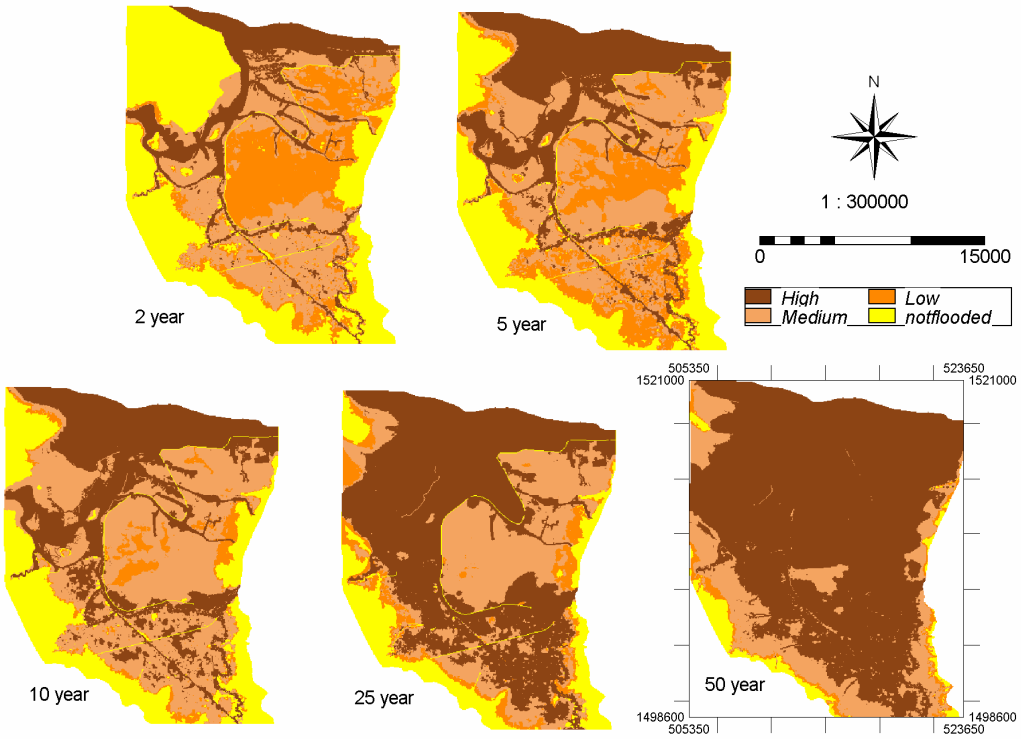


Figure 6-9 Flood hazard map based on multiple parameters: flow velocity, water depth and warning time map

6.2.3. Comparison of single and multiple parameter categorization

Comparison between single and multiple parameters for creating flood hazard maps were made to see how much two types of flood hazard maps differ. Figure 6-10 shows percentage of hazard classes for different return periods based on different parameters.

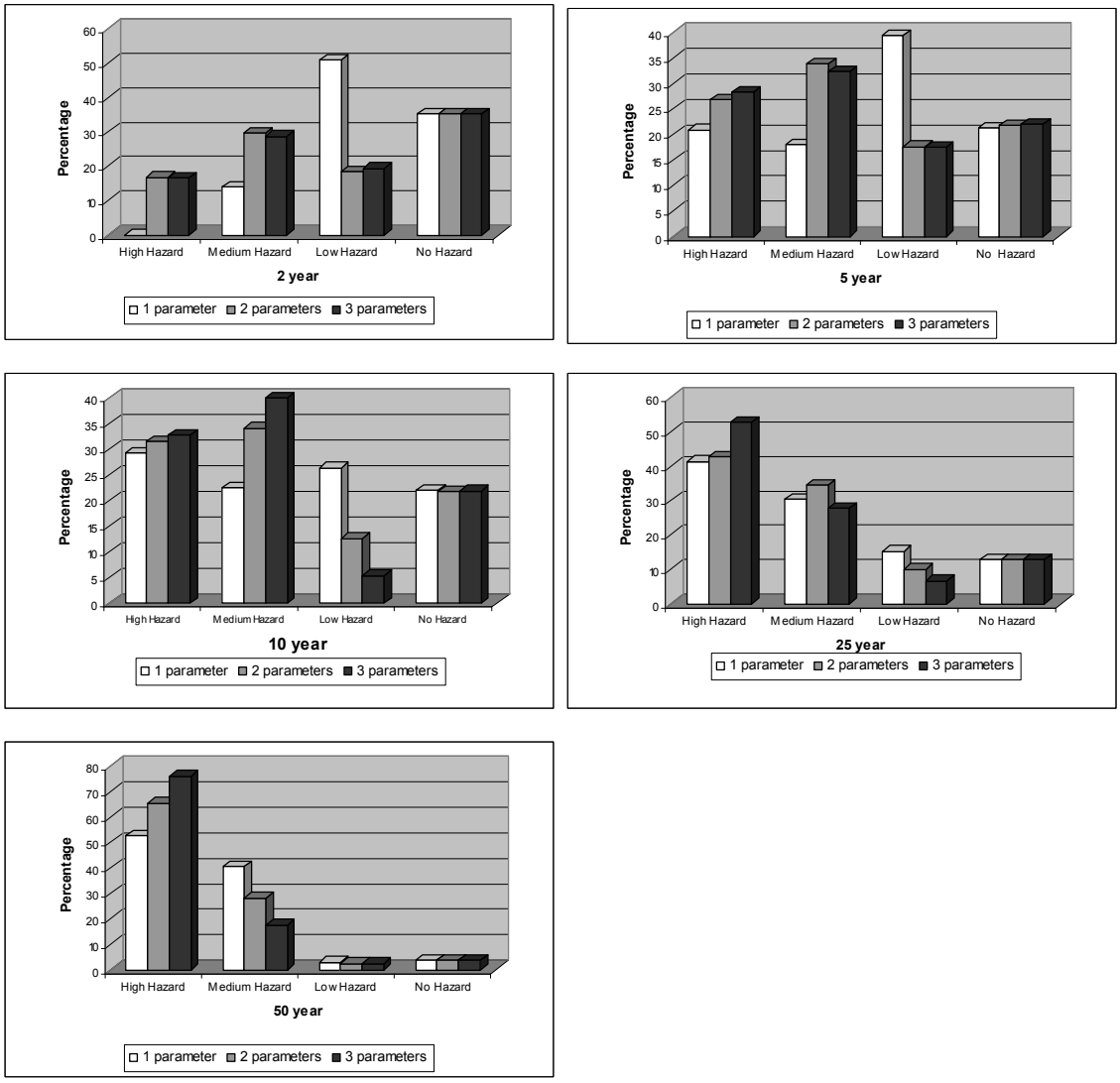


Figure 6-10 Comparison of hazard classes for different return period based on three different parameters: 1 parameter (inundation depth), 2 parameters (inundation depth and flow velocity) and 3 parameters (inundation depth, flow velocity and warning time map)

7. Discussion of Results

7.1. Generation of Digital Elevation Model

Since the DEM is the foundation of the model, the accuracy of the model result so much depends of the DEM representing the topography of the area. Thus, the construction of DEM should be done as accurately as possible.

The data used for creating the DEM is the integration of spot heights and contour lines derived from different scales. The data for southern parts of the study area was accurate as the sources were from the detailed topographic maps of 1:4,000 scaled. However, for the northern part, the sources were from topographic maps with the scale of 1:10,000 and 1:50,000. This part was assumed to be less accurate than that of the northern parts. In other words, the southern part was more accurately represented than in the northern part.

The spot heights were also obtained from the integration of the two sources mentioned above. There were 10837 active points that were used to be integrated with the contour lines. Those integrations were interpolated to create the DEM of the floodplain. The DEM of the floodplain was then combined with the DEM of the embankment to create the final DEM.

In the process of creating DEM of the embankment, the representation of embankment height was derived from interpolation of some known points representing height of embankments. This of course reduces the accuracy of reality of the real height of the embankments. Ways of interpolation for embankment heights is shown in Figure 7-1.

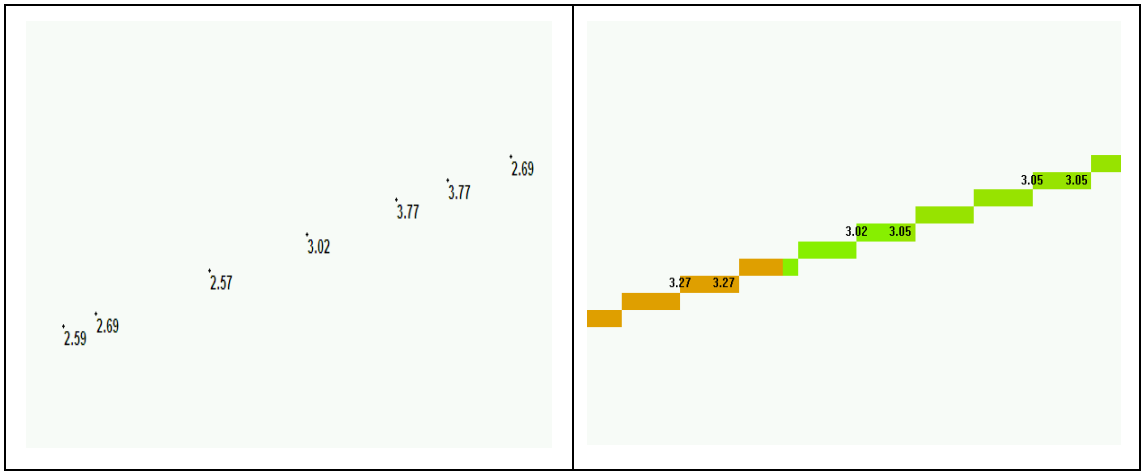


Figure 7-1 Point maps of embankment height (left) and result of those points' interpolation to derive the height of all embankments (right).

To create the final DEM, the interpolated height of embankment in the DEM of the embankment was integrated with DEM of the floodplain. Some pixel values representing floodplain and embankment heights can be seen in Figure 7-2.

Observing the values of the embankments, there is a difference between one pixel with value of 2.77 m jumping to 3.02 m (see Figure 7-2). That can be said as a very rough estimation of embankment height, which occurred in some points. Though in model implication that did not affect the function of embankment, it however affected the water level in the adjacent pixels on the floodplain when the water overflows the embankments.

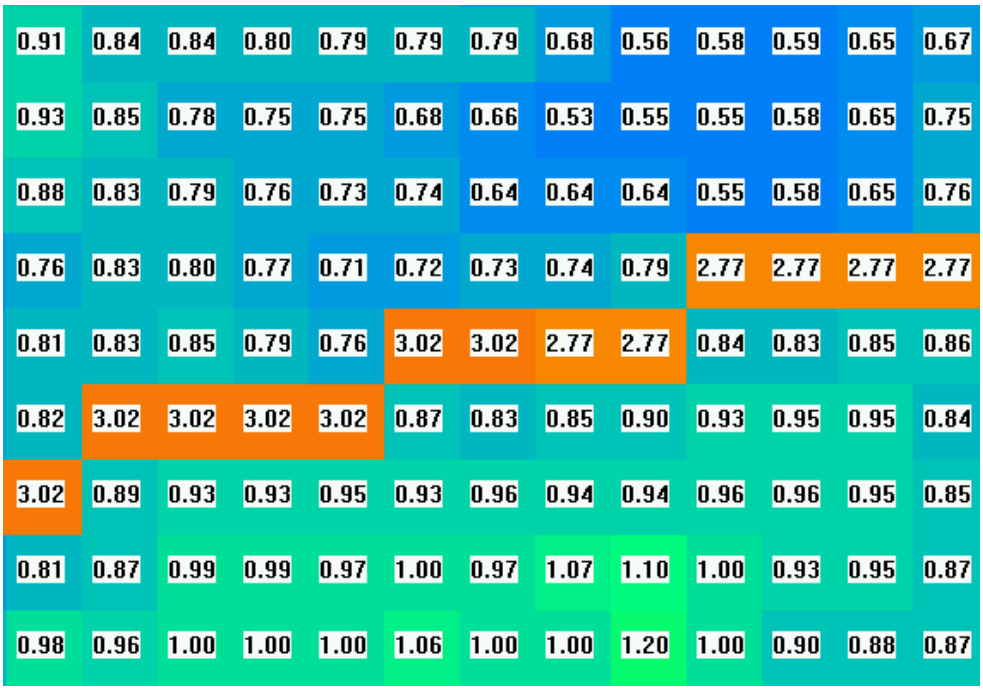


Figure 7-2 Pixel arrangement of embankment with its height value in each pixel

7.2. Model Results vs. Reference Model

7.2.1. Flood Extent

One of the difficulties found in flood hazard management in Bicol River Basin is the lack of the instrument in recording river flow. There have been five water level stations in the Bicol Basin: Camaligan, Sipocot, Ombao, Bato, Buhi. None of the two water level stations which are located in the study area (Camaligan and Sipocot) is in good condition or have been not function well due to the storm induced in the Bicol River.

Since there is no real measurement data, the model results was validated with the 2003 model made by NIPPON KOEI Consultant in Bicol River Basin and Watershed Management Program. The model has been used as the reference flood model in the

Bicol River Basin and has been used to test a range of flood model scenarios for the purpose of river basin management in Bicol Region including flood alleviation works for flood mitigation (Nippon KOEI CO, 2003).

In comparing the flood extent map, there was a very little difference between the model result and the reference model. The difference in percentage was very little. There was 3.44 % for return period of 5 years, 7.91 % for return period of 10 years and 4.26 % for return period of 25 years (Figure 7-3). Hence, the biggest difference was at the return period of 10 years, which is also less than 8 %.

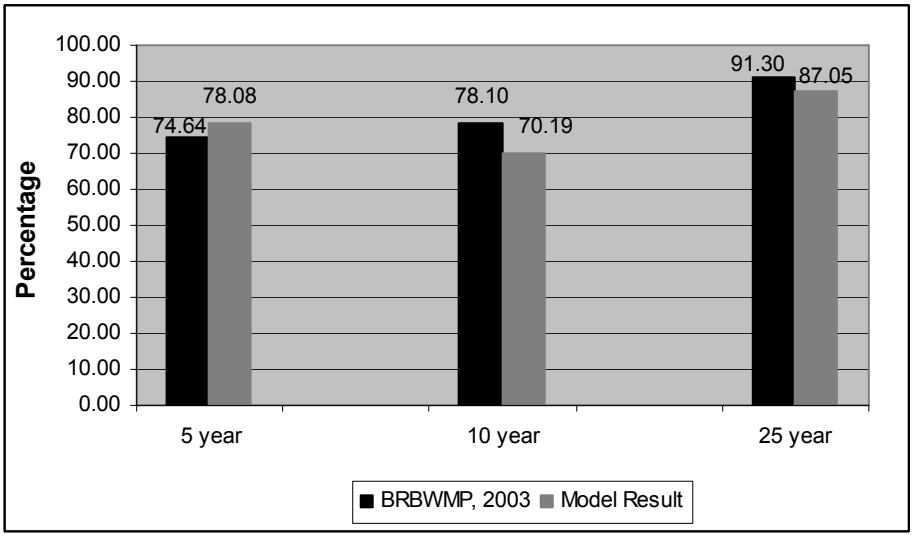


Figure 7-3 Graphical comparison of percentage of flooded area for return period of 5, 10 and 25 years

Considering the less percentage difference from the reference model, the results of the model shows a good result. However, if the difference was carefully analyzed by converting it into the area difference, it is a big difference (see Table 7.1)

Table 7-1 The difference of flooded area between model result and reference model for return period of 5, 10 and 25 years

	Percentage Flooded		
	5 Year	**10 year**	**25 year**
BRBWMP 2003	74.64	78.10	91.30
Model Result	78.08	70.19	87.05
Difference			
Percentage	3.44	7.91	4.26
Nu. of pixels	4463	10299	5545
area (m^2)	11157500	25747500	13862500
area (km^2)	11.16	25.75	13.86
remark	***over-estimate***	***under-estimate***	***under-estimate***

Based on the table above, it was obtained that the model results show an over estimate of flood of 11.16 km^2 for return period of 5 years, 25.75 km^2 under-estimate of flood for return period of 10 years and 13.86 km^2 under-estimate of flood for return period of 25 years. It means that the model result shows that for return period of 5 years, there was 11.16 km^2 more flooded area than the reference model. For return periods of 10 year, there were 25.75 km^2 areas which are not flooded, but in fact flooded in the reference model. The same thing applied for return periods of 25 years, where there were 13.86 km^2 areas which is not flooded, but flooded in the model reference.

7.2.2. Water Level Model

Water level model was calibrated with the water level from the 2003 model from Bicol River Basin and Watershed Management Program. Calibration results between the model results and the reference model for return period of 5, 10 and 25 years can be seen in Table 5-2, Table 5-3 and Table 5-4. Each table shows difference between the model result and the reference model.

Scatter plot of the model results and the reference model shows agreement or more or less similar results. Comparison of the results of 2-, 5- and 25-year return periods with the reference model clearly showed positive relation, does not deviate from the expected line x=y. It can therefore be concluded that these datasets have lot significance for model calibration. Calibration of the model results for return period of 2-, 5- and 25-year return period can be seen in Figure 7-4, Figure 7-5 and Figure 7-6.

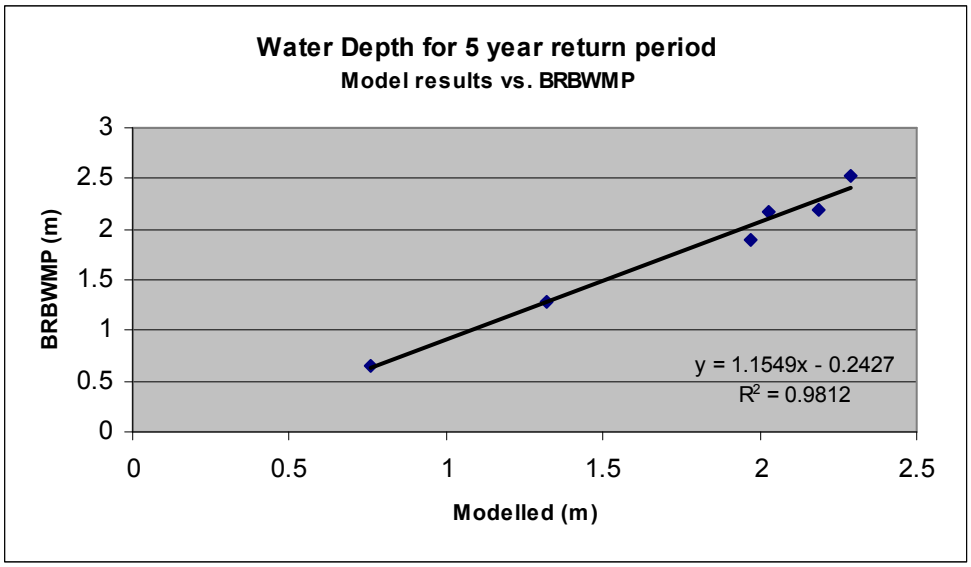


Figure 7-4 Comparison between simulated water level and reference model for return period of 5 years

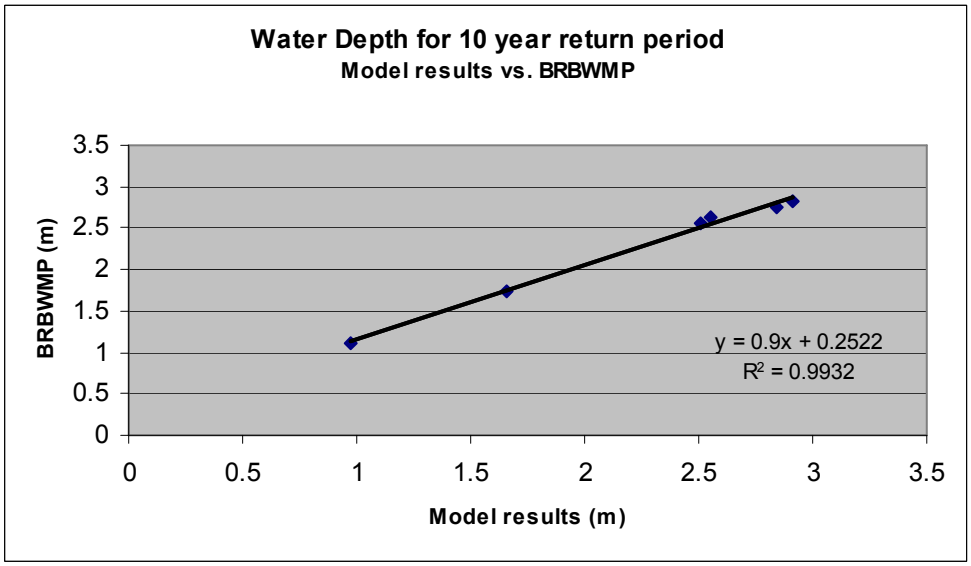


Figure 7-5 Comparison between simulated water level and reference model for return period of 10 years

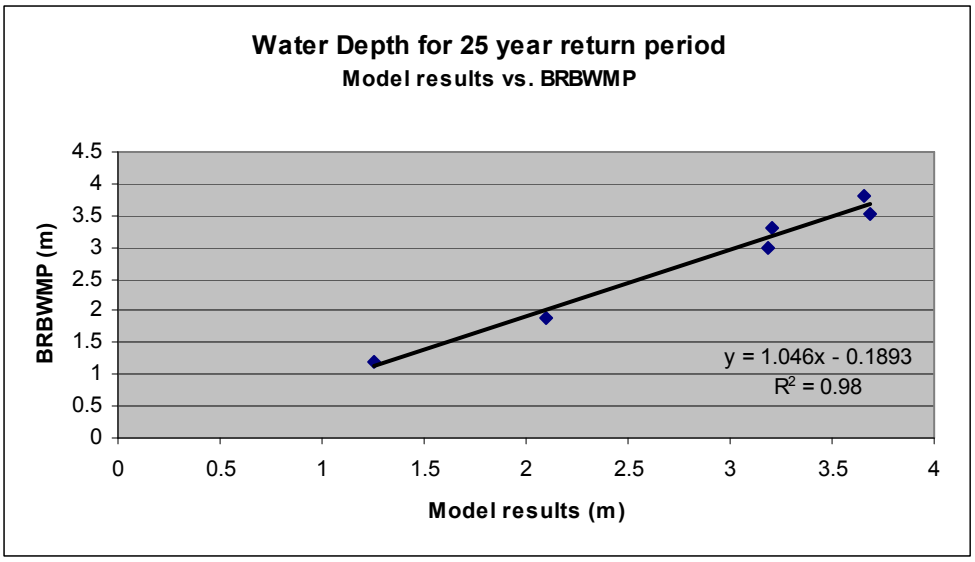


Figure 7-6 Comparison between simulated water level and reference model for return period of 25 years

The three results from different return periods have high correlation with the reference models. The correlation is 0.98-0.99 for the three modelled flood events that are calibrated. This is a very high correlation for such a calibration.

However, in addition to the high correlation values for the three calibrated results, these things should be considered:

- The water level is only calibrated at six points, each of which is located in one sub basin. The calibrated points were chosen due to the available calibrating peak flow from the reference model, which are in the sub basin of Pamplona, Cabusao, Canaman, San Fernando, Balongay, and Libmanan.
- The water level was not spatially calibrated. Though the model results provided spatial water level at every pixel, the calibrating values did not. The calibrating water level was obtained from the final report on the basin plan for the water resources development and management report (Nippon KOEI CO, 2003). It only gave the water level at sub basins as found in the report, which is used for calibrating. Hence, the calibration was done not on the base of pixel to pixel, but by observing the water level at some sub basins from the model result where the same data available from the reference model.

7.2.3. Warning Time

Warning time is a further step after the flood forecasting to inform people about the time when flood comes, according to the forecasting. The importance of the flood forecasting and warning is widely recognized as a vital non-structural measures to aid the mitigating the loss of life, crops and property caused by the flood occurrence.

In this research, warning time is defined as the time when the water first comes to each pixel representing the floodplain. It is based on the assumptions that the people need to be ready and rescue themselves and their property when the water comes. The time

when particular depth of water occurs at the floodplain, which can be dangerous to the people and the property, was not considered.

Keys (1993) proposed that warning time should be based on description of the severity of community impact at particular water heights so that 'critical levels' can be determined at which responses of particular types and intensities will become necessary. This would include information on particular institutions (schools, hospitals, homes for the aged, and the like) and on the number of people who could need to be evacuated (Keys, 1993).

Adopting the description of Keys, 1993 above, it is necessary to build a warning system based on some variable parameters. For instance, in defining the warning system, the landuse laid on the floodplain should be considered and made weights according to the importance and degree of loss due to flood. Scenario developments should be applied by analyzing some factors that play role in making the warning time.

7.2.4. Flood Hazard Mapping

The level of hazard of a flood event depends very much on parameters used. Conventionally, flood hazard was made based on depth parameter. For other purposes, e.g. for calculating damages, flow velocity is used as parameter.

However, to create a flood hazard map that can be used properly for risk assessment, it is considered important to incorporate other flood parameters. CSIRO (2000) refers to the degree of flood hazard as being a function of:

- the size (magnitude) of flooding
- depth and velocity (speed of flowing water)
- rate of floodwater rise
- duration of flooding
- evacuation problems
- effective flood access
- size of population at risk

The information required for deriving velocity of overland flow, duration and warning time of flood can not be obtained from 1D modelling. Making use of the advantage of 2D modelling as applied in this research, the outputs of the models were integrated and manipulated to derive flood hazard maps.

It clearly showed that using different parameters, single or multiple categorization, the flood hazard maps will be different, as well. This research tried to see the difference of the different flood hazard categorization for different return period of floods, in which the results can be seen in Figure 7-7, Figure 7-8, Figure 7-9, Figure 7-10 and Figure 7-11.

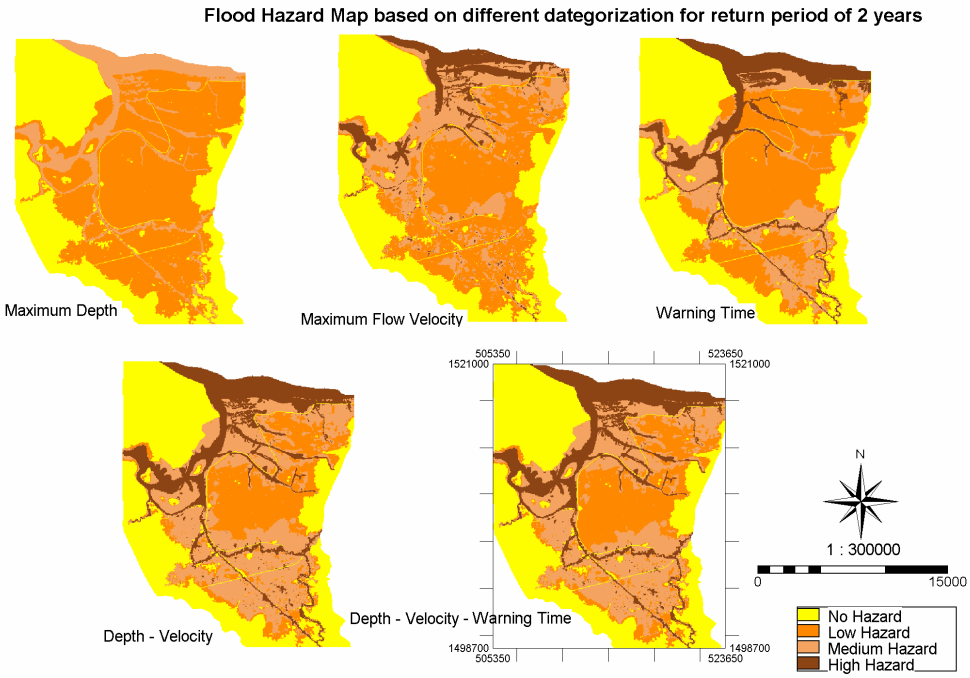


Figure 7-7 Comparison of flood hazard map based on different categorization for return period of 2 years

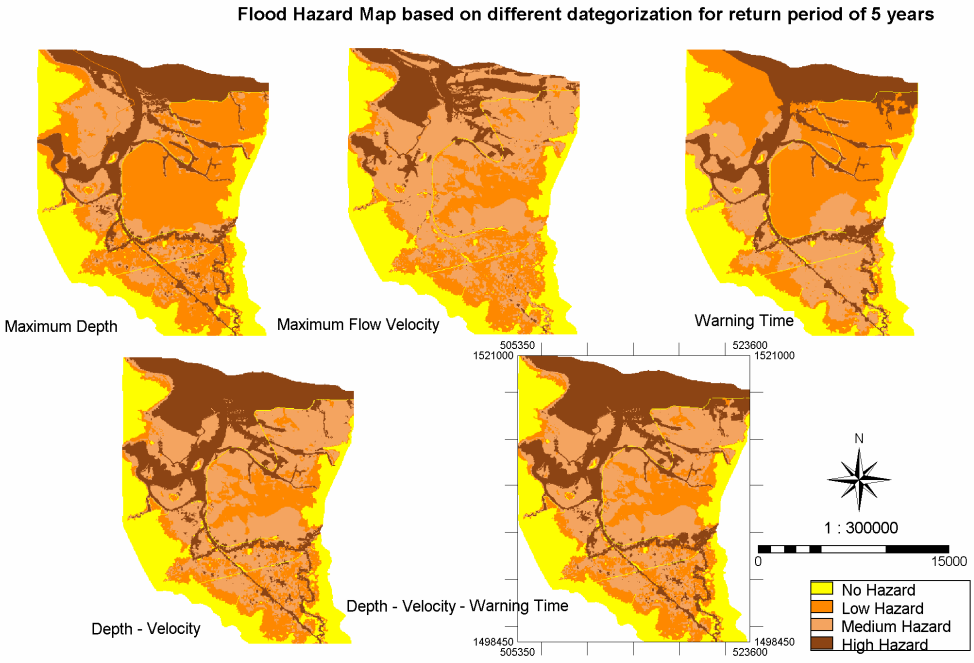


Figure 7-8 Comparison of flood hazard map based on different categorization for return period of 5 years

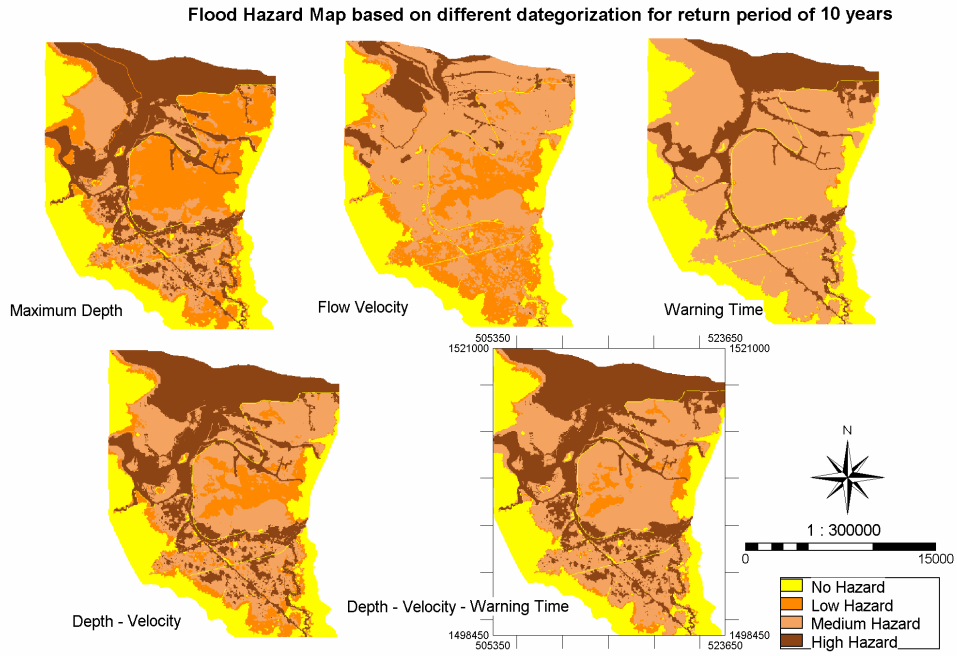


Figure 7-9 Comparison of flood hazard map based on different categorization for return period of 10 years

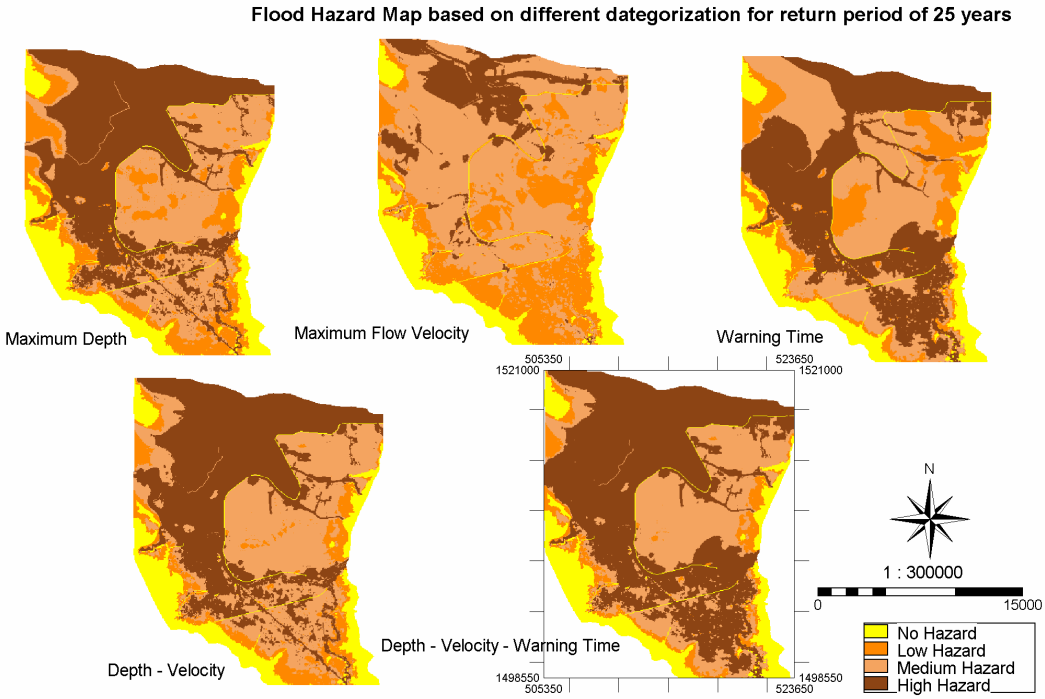


Figure 7-10 Comparison of flood hazard map based on different categorization for return period of 25 years

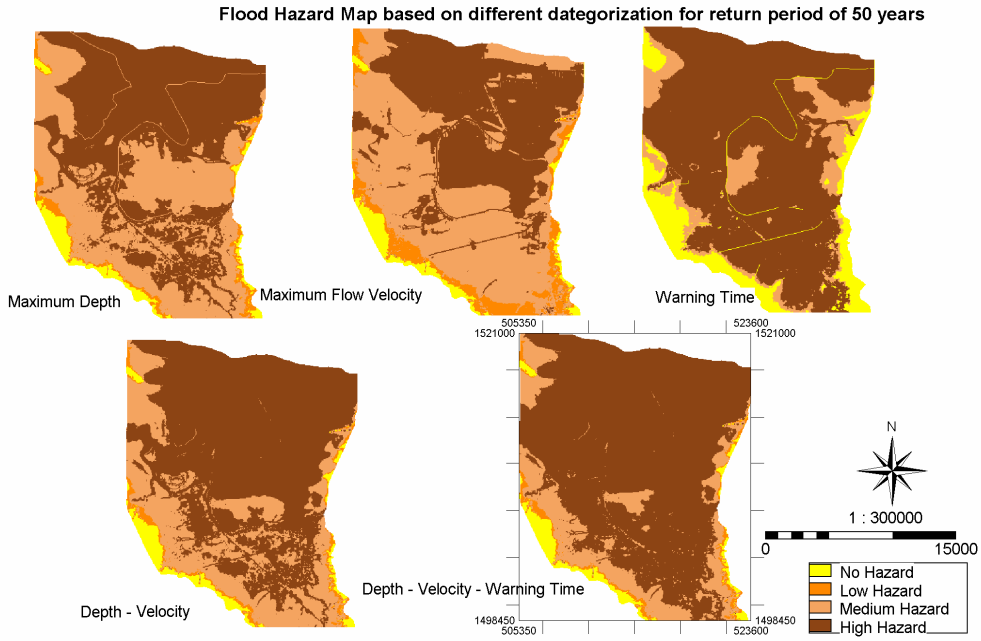


Figure 7-11 Comparison of flood hazard map based on different categorization for return period of 50 years

It is a well known matter of fact that it is necessary to divide the floodplain into flood hazard categories that reflect the flood behaviour across the floodplain. The best combination depends on how we are going to use the flood hazard. Reliable flood maps can be derived from the combinations of hazard components by incorporating some factors as, for instance, proposed by CSIRO.

8. Conclusion and Recommendation

8.1. Conclusion

This study shows the application of combined 1D-2D modelling. The main objective of this research is to model the flood propagation in the Lower Bicol Floodplain for flood events with different return period. The objective was achieved and several maps had been derived to show the difference behaviour of floods at different return periods. For the events modelled on this research, the following conclusions can be drawn from model behaviours:

- The Digital Elevation Model (DEM), which represents the floodplain's surface, is the basis in the flood modelling. The DEM in this research was derived from integration of spot height and contour lines from different sources and scales. The DEM in the northern part was constructed from less detailed sources (1:10,000 and 1:50,000) compared to the southern part, which is 1:4,000.
- Maximum depth of inundation increased with the smaller probability of floods to occur. The most extreme depth of water occurred in the flood with return period of 50 years where more than 50% of the area was predicted to be inundated between 3 to 4 meters. Maximum depth, which is 6 meters, only occurs in this event. In the 2-year flood, it was predicted that peak water depths exceeding 2.5 meter were restricted to the main channels.
- Result of history stations showed that the water reaches its peak flow at the 60th hour and continuously decreased until the fifth day of simulation. Maximum simulated velocities decrease from the large flood (small probability to occur) to small flood (bigger probability). Maximum flow velocity at some points in the area was 1.58 m/s in the return period of 2 years to reach 3.47 m/s and 4.84 m/s in the return period of 25 and 50 years. In general, high velocities occurred in the straight channels in the estuary.
- Validated with the 2003 model of Nippon Koei in Bicol River Basin and Watershed Management Programme, the result of flood extent showed that there was 95.59% agreement for return period of 5 years, 89.97% for return period of 10 years and 95.33% for return period of 50 years. For water level calibration, scatter plots of the model results and the reference model show good agreement with 0.98 correlation coefficient for return period of 5 and 25 years and 0.99 for return period of 10 years.
- Considering that flood hazard map, which is produced from the model results, can be used for disaster management, this research proposed hazard maps based on single and multiple categorisation. It was found that different parameters, either single or multiple, created different flood hazard maps. It is realized that flood hazard map is made depending on the purpose of the flood hazard map itself. Thus,

parameters used for creating flood hazard map will depend on the use of flood hazard map itself.

8.2. Limitation of the Research

This research aims at applying flood propagation model to predict and model the flood events for different return periods of floods, which are 2, 5, 10, 25 and 50 years. The data used for the input are based on the concept of model coupling, in which one model is executed first and the result of the model is used for the input of this modelling. Thus, the input of the model uses the model output of the MIKE 11 model developed by NIPPON KOEI, 1991 in Bicol River Basin Flood Control and Irrigation Development Project (BRBFCIDP).

Distinguishing different return period of floods is mainly done by using one variable, which is a different discharge and water level value for different return period of floods. However, it is a well known matter of fact that the geomorphology is also changed from time to time as the changing of man-made artefacts like embankments, etc. Not to mention 50 years, within 5 or ten years, there could be changes in the geomorphological features within one area, especially in the low-land area where erosion and sedimentation can take place simultaneously as well as man-made modifications of the terrain. In addition, sedimentation from Mayon Volcano has accelerated after several eruptions that resulted in changes of the morphology of the river, particularly in the channel itself. These kinds of changes were not included in the modelling parameters.

8.3. Recommendation

The combined 1D2D opens up possibilities for studying flood control measures, flood forecasting and development of flood evacuation plans. Information from the model can be used as a source for flood risk assessment and can be useful for decision making. For basin planning and management, this model can be used as reference for identifying free lands for future development in the Bicol River Basin, especially in the lower part on which this research is focused. In addition, detailed visualisation from 1D2D flood model would help basin management planners and basin managers convey what recommendations and solutions should be considered or discarded for future planning and explain why such options are recommended or discarded.

For future related studies or researches, these recommendations should be considered:

- In modelling flood behaviour for such bigger return periods, e.g. 25 and 50 years, it is recommended to conduct it in the bigger area as the difference can be seen clearly. The research area is too small for such modelling and it only considers areas with 5 meter maximum latitude. In this case, in modelling such different return period of flood events, the whole Bicol basin is recommended.
- Technically, in similar modelling, the duration of simulation is recommended to be made different at different return period of floods. Based on the simulation result, it

was observed that there was not different duration between 2, 5, 10, 25 and 50 years return period of floods, only the different at velocity and the depth of water. However, the flow velocity recorded at some history stations shows that flood events at return period of 25 and 50 years were still continued to flow. From this, it is assumed that simulation time should be made longer for the bigger return period of floods.

- As the flood in the Bicol basin is aggravated by sedimentation from the Mayon Volcano, integrating the accelerated sedimentation from Mayon Volcano in the upper part of the catchments with this modelling would be a very interesting work. By this, the real situation will be more represented
- Modelling future events should also consider the dynamic changing of the geomorphology of the floodplain and landuse.

9. References

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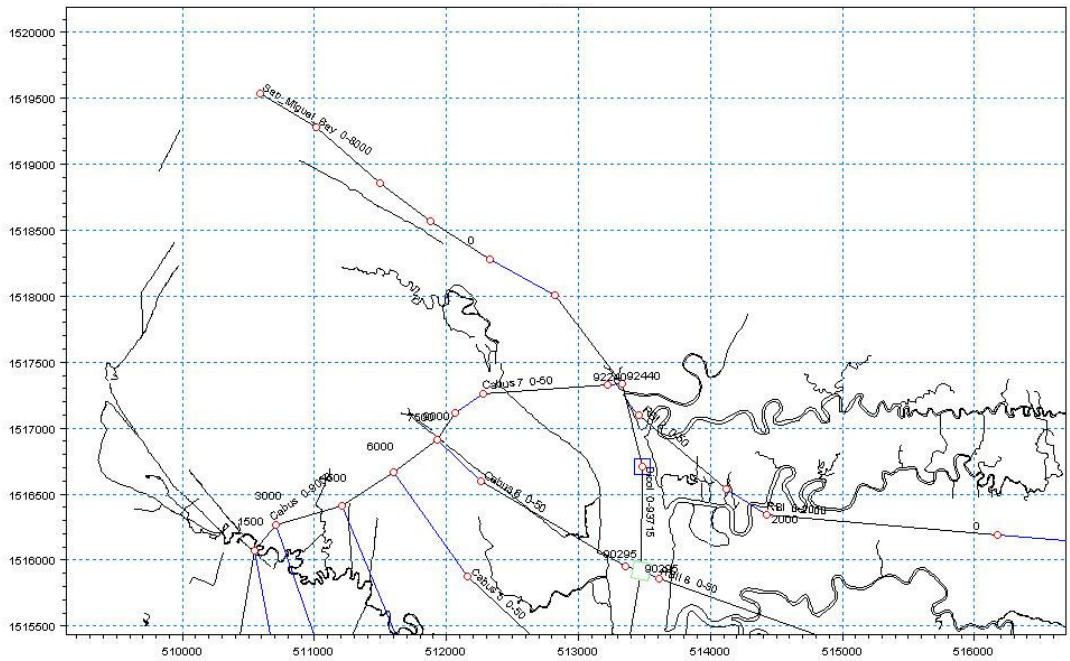
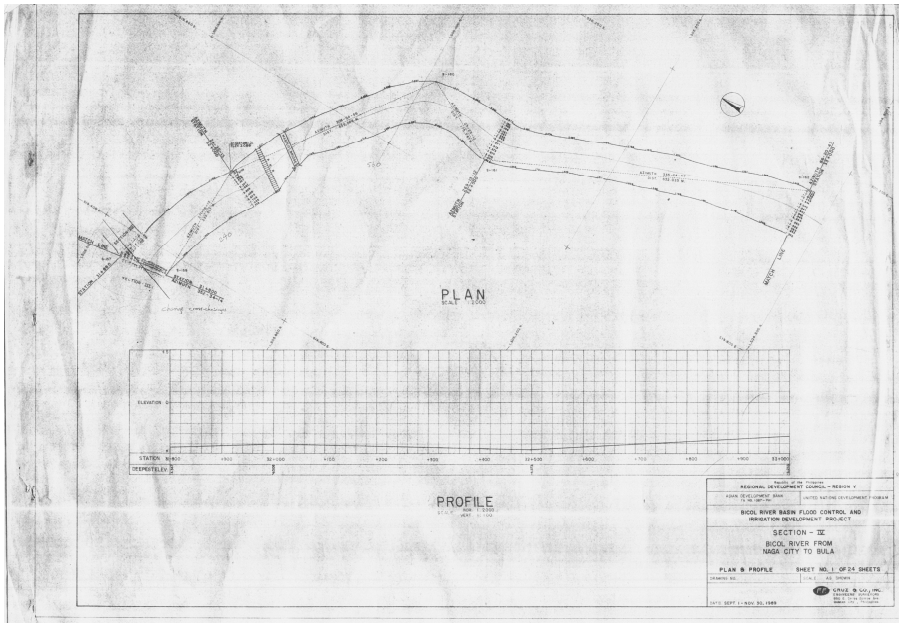
10. Appendices

10.1. Example Source of Cross Sections Data



River Network in Bicol River confluence to San Miguel Bay



River cross section in Naga River

10.2. Information about simulation (2 year return period)

```
Information about Simulation
============================

Simulation Mode                     : Run channel flow module
simultaneously with overland-flow module

Start                               : 21-January-2005 12:57:15
End                                 : 22-January-2005 00:03:05

Rainfall-Runoff Module used         : No
Channel Module used                 : Yes
Sewer Module used                   : No
1D2D Module used                    : Yes
Real Time Control Module used       : No
Water Quality Module used           : No
Emission Module used                : No
Ground Water Module used            : No
Simulation parallel                 : No
Flow modules unsteady               : Yes

Network imported or started         : FromScratch
Network imported at                 : 1/10/2005 10:00:14 AM


Balance of Channel Flow Module
======================

Under License to                    : SOBEK licensee

Numerical Parameters Used
=========================
Accuracy Level                      : Low Speed/More Accurate
Structure Stability Factor          :  0
Conveyance factor K                 :  T
Conveyance factor K-Table           :  F
Theta                               :            1.00
Maximum Courant getal               :            1.00
Epsilon value Volume (m3/s)         :      0.00010000
Epsilon value Level (m)             :      0.00010000
Threshold Values ...
Flooding (m)                        :         0.01000
Drying (m)                          :         0.00100
Threshold Values OF ...
Flooding (m)                        :         0.00100
Drying (m)                          :         0.00010
Minimum Lengte Reach Segment        :            1.00
Relaxation Factor (0..1)            :            1.00
Structure Dynamics Factor           :            1.00
Maximum Iteraties                   :               8
Gravity g (m2/s)                    :            9.81
Fluid Density (m3)                  :         1000.00
Timestep size (s)                   :        600.0000
Lowest Timestep (s)                 :          0.0017
Largest Timestep (s)                :         75.0000
External structure                   Spilled volume (m3)

Boundaries in (m3)                  :    660397602.77
```

```
Boundaries out (m3)                :    586024511.79
Structures in (m3)                 :            0.00
Structures out (m3)                :            0.00
Lateral disch. in (m3)             :            0.00
Lateral disch. out (m3)            :            0.00
Storage (m3)                       :     74373175.13
Error (m3)                         :          -84.15

Initial conditions
==================
Flow Module                        : user defined


Version Information of Modules
==============================

Vervang             : 6/27/2000 10:28:08 AM, Version: 4.05.012
Caseman             : 2/26/2002 9:38:52 AM, Version: 4.06.00
CmUtil              : 2/26/2002 9:52:20 AM, Version: 4.06.00
CmUpdate            : 2/26/2002 9:58:48 AM, Version: 4.06.00
3B                  : 6/6/2003 3:33:22 PM, Version: 3.208.69
Parsen              : 3/4/2003 1:01:54 PM, Version: 2.01.34
Parsen2D            : 4/14/2003 4:32:06 PM, Version: 1.01.10
Flow                : 8/5/2003 11:32:34 AM, Version: 3.06.14.2
RTC-Matlab 5.3      : 5/27/2003 4:50:36 PM, Version: 3.208.34
RTC-Matlab 6.0      : 5/28/2003 11:36:34 AM, Version: 3.208.34
RTC-Matlab 6.1      : 5/28/2003 11:36:56 AM, Version: 3.208.34
RTC-Matlab 6.5      : 5/28/2003 11:37:18 AM, Version: 3.208.34
EM                  : 10/14/2001 9:20:42 PM, Version: 1.00.0001
Delwaq1             : 4/3/2002 2:21:08 PM, Version:
Delwaq1p            : 4/3/2002 2:22:46 PM, Version:
Delwaq2             : 1/30/2003 1:01:20 PM, Version:
Waterbal            : 1/10/2003 11:22:18 AM, Version: 2.00.02
Simulate            : 11/7/2002 4:46:30 PM, Version: 2.06.0078

SOBEKVersion   = Sobek Advanced Version 2.08.002
```

10.3. Information about simulation (5 year return period)

```
Information about Simulation
============================

Simulation Mode                     : Run channel flow module
simultaneously with overland-flow module

Start                               : 21-January-2005 12:05:14
End                                 : 22-January-2005 00:09:49

Rainfall-Runoff Module used         : No
Channel Module used                 : Yes
Sewer Module used                   : No
1D2D Module used                    : Yes
Real Time Control Module used       : No
Water Quality Module used           : No
Emission Module used                : No
Ground Water Module used            : No
Simulation parallel                 : No
Flow modules unsteady               : Yes

Network imported or started         : FromScratch
Network imported at                 : 1/10/2005 10:00:14 AM

Balance of Channel Flow Module
======================

Under License to                    : SOBEK licensee

Numerical Parameters Used
=========================
Accuracy Level                      : Low Speed/More Accurate
Structure Stability Factor          :  0
Conveyance factor K                 :  T
Conveyance factor K-Table           :  F
Theta                               :            1.00
Maximum Courant getal               :            1.00
Epsilon value Volume (m3/s)         :      0.00010000
Epsilon value Level (m)             :      0.00010000
Threshold Values ...
Flooding (m)                        :         0.01000
Drying (m)                          :         0.00100
Threshold Values OF ...
Flooding (m)                        :         0.00100
Drying (m)                          :         0.00010
Minimum Lengte Reach Segment        :            1.00
Relaxation Factor (0..1)            :            1.00
Structure Dynamics Factor           :            1.00
Maximum Iteraties                   :               8
Gravity g (m2/s)                    :            9.81
Fluid Density (m3)                  :         1000.00
Timestep size (s)                   :        600.0000
Lowest Timestep (s)                 :          0.0017
Largest Timestep (s)                :         66.6667

External structure                   Spilled volume (m3)
Boundaries in (m3)                  :    781044450.35
Boundaries out (m3)                 :    661490206.37
Structures in (m3)                  :            0.00
```

```
Structures out (m3)                :            0.00
Lateral disch. in (m3)             :            0.00
Lateral disch. out (m3)            :            0.00
Storage (m3)                       :    119554324.20
Error (m3)                         :          -80.22
Initial conditions
==================
Flow Module                        : user defined


Version Information of Modules
==============================

Vervang           : 6/27/2000 10:28:08 AM, Version: 4.05.012
Caseman           : 2/26/2002 9:38:52 AM, Version: 4.06.00
CmUtil            : 2/26/2002 9:52:20 AM, Version: 4.06.00
CmUpdate          : 2/26/2002 9:58:48 AM, Version: 4.06.00
3B                : 6/6/2003 3:33:22 PM, Version: 3.208.69
Parsen            : 3/4/2003 1:01:54 PM, Version: 2.01.34
Parsen2D          : 4/14/2003 4:32:06 PM, Version: 1.01.10
Flow              : 8/5/2003 11:32:34 AM, Version: 3.06.14.2
RTC-Matlab 5.3    : 5/27/2003 4:50:36 PM, Version: 3.208.34
RTC-Matlab 6.0    : 5/28/2003 11:36:34 AM, Version: 3.208.34
RTC-Matlab 6.1    : 5/28/2003 11:36:56 AM, Version: 3.208.34
RTC-Matlab 6.5    : 5/28/2003 11:37:18 AM, Version: 3.208.34
EM                : 10/14/2001 9:20:42 PM, Version: 1.00.0001
Delwaq1           : 4/3/2002 2:21:08 PM, Version:
Delwaq1p          : 4/3/2002 2:22:46 PM, Version:
Delwaq2           : 1/30/2003 1:01:20 PM, Version:
Waterbal          : 1/10/2003 11:22:18 AM, Version: 2.00.02
Simulate          : 11/7/2002 4:46:30 PM, Version: 2.06.0078

SOBEKVersion   = Sobek Advanced Version 2.08.002
```

10.4. Information about simulation (10 year return period)

```
Information about Simulation
============================

Simulation Mode                     : Run channel flow module
simultaneously with overland-flow module

Start                               : 19-January-2005 19:49:43
End                                 : 20-January-2005 09:08:36

Rainfall-Runoff Module used         : No
Channel Module used                 : Yes
Sewer Module used                   : No
1D2D Module used                    : Yes
Real Time Control Module used       : No
Water Quality Module used           : No
Emission Module used                : No
Ground Water Module used            : No
Simulation parallel                 : No
Flow modules unsteady               : Yes

Network imported or started         : FromScratch
Network imported at                 : 1/10/2005 10:00:14 AM

Balance of Channel Flow Module
======================

Under License to                    :           SOBEK licensee

Numerical Parameters Used
=========================
Accuracy Level                      : Low Speed/More Accurate
Structure Stability Factor          :  0
Conveyance factor K                 :  T
Conveyance factor K-Table           :  F
Theta                               :            1.00
Maximum Courant getal               :            1.00
Epsilon value Volume (m3/s)         :      0.00010000
Epsilon value Level (m)             :      0.00010000
Threshold Values ...
Flooding (m)                        :         0.01000
Drying (m)                          :         0.00100
Threshold Values OF ...
Flooding (m)                        :         0.00100
Drying (m)                          :         0.00010
Minimum Lengte Reach Segment        :            1.00
Relaxation Factor (0..1)            :            1.00
Structure Dynamics Factor           :            1.00
Maximum Iteraties                   :               8
Gravity g (m2/s)                    :            9.81
Fluid Density (m3)                  :         1000.00
Timestep size (s)                   :        600.0000
Lowest Timestep (s)                 :          0.0017
Largest Timestep (s)                :         66.6667

External structure                   Spilled volume (m3)
Boundaries in (m3)                  :    776085502.22
Boundaries out (m3)                 :    655872951.78
Structures in (m3)                  :            0.00
```

```
Structures out (m3)                :            0.00
Lateral disch. in (m3)             :            0.00
Lateral disch. out (m3)            :            0.00
Storage (m3)                       :    120212620.94
Error (m3)                         :          -70.49
Initial conditions
==================
Flow Module                        : user defined


Version Information of Modules
==============================

Vervang            : 6/27/2000 10:28:08 AM, Version: 4.05.012
Caseman            : 2/26/2002 9:38:52 AM, Version: 4.06.00
CmUtil             : 2/26/2002 9:52:20 AM, Version: 4.06.00
CmUpdate           : 2/26/2002 9:58:48 AM, Version: 4.06.00
3B                 : 6/6/2003 3:33:22 PM, Version: 3.208.69
Parsen             : 3/4/2003 1:01:54 PM, Version: 2.01.34
Parsen2D           : 4/14/2003 4:32:06 PM, Version: 1.01.10
Flow               : 8/5/2003 11:32:34 AM, Version: 3.06.14.2
RTC-Matlab 5.3     : 5/27/2003 4:50:36 PM, Version: 3.208.34
RTC-Matlab 6.0     : 5/28/2003 11:36:34 AM, Version: 3.208.34
RTC-Matlab 6.1     : 5/28/2003 11:36:56 AM, Version: 3.208.34
RTC-Matlab 6.5     : 5/28/2003 11:37:18 AM, Version: 3.208.34
EM                 : 10/14/2001 9:20:42 PM, Version: 1.00.0001
Delwaq1            : 4/3/2002 2:21:08 PM, Version:
Delwaq1p           : 4/3/2002 2:22:46 PM, Version:
Delwaq2            : 1/30/2003 1:01:20 PM, Version:
Waterbal           : 1/10/2003 11:22:18 AM, Version: 2.00.02
Simulate           : 11/7/2002 4:46:30 PM, Version: 2.06.0078

SOBEKVersion   = Sobek Advanced Version 2.08.002
```

10.5. Information about simulation (25 year return period)

```
Information about Simulation
============================

Simulation Mode                     : Run channel flow module
simultaneously with overland-flow module

Start                               : 21-January-2005 12:05:14
End                                 : 22-January-2005 00:09:49

Rainfall-Runoff Module used         : No
Channel Module used                 : Yes
Sewer Module used                   : No
1D2D Module used                    : Yes
Real Time Control Module used       : No
Water Quality Module used           : No
Emission Module used                : No
Ground Water Module used            : No
Simulation parallel                 : No
Flow modules unsteady               : Yes

Network imported or started         : FromScratch
Network imported at                 : 1/10/2005 10:00:14 AM

Balance of Channel Flow Module
======================

Under License to                    : SOBEK licensee

Numerical Parameters Used
=========================
Accuracy Level                      : Low Speed/More Accurate
Structure Stability Factor          :  0
Conveyance factor K                 :  T
Conveyance factor K-Table           :  F
Theta                               :            1.00
Maximum Courant getal               :            1.00
Epsilon value Volume (m3/s)         :      0.00010000
Epsilon value Level (m)             :      0.00010000
Threshold Values ...
Flooding (m)                        :         0.01000
Drying (m)                          :         0.00100
Threshold Values OF ...
Flooding (m)                        :         0.00100
Drying (m)                          :         0.00010
Minimum Lengte Reach Segment        :            1.00
Relaxation Factor (0..1)            :            1.00
Structure Dynamics Factor           :            1.00
Maximum Iteraties                   :               8
Gravity g (m2/s)                    :            9.81
Fluid Density (m3)                  :         1000.00
Timestep size (s)                   :        600.0000
Lowest Timestep (s)                 :          0.0017
Largest Timestep (s)                :         66.6667

External structure                   Spilled volume (m3)
Boundaries in (m3)                  :    781044450.35
Boundaries out (m3)                 :    661490206.37
Structures in (m3)                  :            0.00
```

```
Structures out (m3)                :            0.00
Lateral disch. in (m3)             :            0.00
Lateral disch. out (m3)            :            0.00
Storage (m3)                       :    119554324.20
Error (m3)                         :          -80.22
Initial conditions
==================
Flow Module                        : user defined


Version Information of Modules
==============================

Vervang            : 6/27/2000 10:28:08 AM, Version: 4.05.012
Caseman            : 2/26/2002 9:38:52 AM, Version: 4.06.00
CmUtil             : 2/26/2002 9:52:20 AM, Version: 4.06.00
CmUpdate           : 2/26/2002 9:58:48 AM, Version: 4.06.00
3B                 : 6/6/2003 3:33:22 PM, Version: 3.208.69
Parsen             : 3/4/2003 1:01:54 PM, Version: 2.01.34
Parsen2D           : 4/14/2003 4:32:06 PM, Version: 1.01.10
Flow               : 8/5/2003 11:32:34 AM, Version: 3.06.14.2
RTC-Matlab 5.3     : 5/27/2003 4:50:36 PM, Version: 3.208.34
RTC-Matlab 6.0     : 5/28/2003 11:36:34 AM, Version: 3.208.34
RTC-Matlab 6.1     : 5/28/2003 11:36:56 AM, Version: 3.208.34
RTC-Matlab 6.5     : 5/28/2003 11:37:18 AM, Version: 3.208.34
EM                 : 10/14/2001 9:20:42 PM, Version: 1.00.0001
Delwaq1            : 4/3/2002 2:21:08 PM, Version:
Delwaq1p           : 4/3/2002 2:22:46 PM, Version:
Delwaq2            : 1/30/2003 1:01:20 PM, Version:
Waterbal           : 1/10/2003 11:22:18 AM, Version: 2.00.02
Simulate           : 11/7/2002 4:46:30 PM, Version: 2.06.0078

SOBEKVersion   = Sobek Advanced Version 2.08.002
```

10.6. Information about simulation (50 year return period)

```
Information about Simulation
============================

Simulation Mode                     : Run channel flow module
simultaneously with overland-flow module

Start                               : 18-January-2005 16:51:31
End                                 : 19-January-2005 17:28:38

Rainfall-Runoff Module used         : No
Channel Module used                 : Yes
Sewer Module used                   : No
1D2D Module used                    : Yes
Real Time Control Module used       : No
Water Quality Module used           : No
Emission Module used                : No
Ground Water Module used            : No
Simulation parallel                 : No
Flow modules unsteady               : Yes

Network imported or started         : FromScratch
Network imported at                 : 1/10/2005 10:00:14 AM

Balance of Channel Flow Module
======================

Under License to                    : SOBEK licensee

Numerical Parameters Used
=========================
Accuracy Level                      : Low Speed/More Accurate
Structure Stability Factor          :  0
Conveyance factor K                 :  T
Conveyance factor K-Table           :  F
Theta                               :            1.00
Maximum Courant getal               :            1.00
Epsilon value Volume (m3/s)         :      0.00010000
Epsilon value Level (m)             :      0.00010000
Threshold Values ...
Flooding (m)                        :         0.01000
Drying (m)                          :         0.00100
Threshold Values OF ...
Flooding (m)                        :         0.00100
Drying (m)                          :         0.00010
Minimum Lengte Reach Segment        :            1.00
Relaxation Factor (0..1)            :            1.00
Structure Dynamics Factor           :            1.00
Maximum Iteraties                   :               8
Gravity g (m2/s)                    :            9.81
Fluid Density (m3)                  :         1000.00
Timestep size (s)                   :        600.0000
Lowest Timestep (s)                 :          0.0017
Largest Timestep (s)                :         66.6667

External structure                   Spilled volume (m3)
Boundaries in (m3)                  :   1784120676.80
Boundaries out (m3)                 :   1580603782.81
Structures in (m3)                  :            0.00
```

```
Structures out (m3)                :            0.00
Lateral disch. in (m3)             :            0.00
Lateral disch. out (m3)            :            0.00
Storage (m3)                       :    203516993.97
Error (m3)                         :          -99.97
Initial conditions
==================
Flow Module                        : user defined


Version Information of Modules
==============================

Vervang            : 6/27/2000 10:28:08 AM, Version: 4.05.012
Caseman            : 2/26/2002 9:38:52 AM, Version: 4.06.00
CmUtil             : 2/26/2002 9:52:20 AM, Version: 4.06.00
CmUpdate           : 2/26/2002 9:58:48 AM, Version: 4.06.00
3B                 : 6/6/2003 3:33:22 PM, Version: 3.208.69
Parsen             : 3/4/2003 1:01:54 PM, Version: 2.01.34
Parsen2D           : 4/14/2003 4:32:06 PM, Version: 1.01.10
Flow               : 8/5/2003 11:32:34 AM, Version: 3.06.14.2
RTC-Matlab 5.3     : 5/27/2003 4:50:36 PM, Version: 3.208.34
RTC-Matlab 6.0     : 5/28/2003 11:36:34 AM, Version: 3.208.34
RTC-Matlab 6.1     : 5/28/2003 11:36:56 AM, Version: 3.208.34
RTC-Matlab 6.5     : 5/28/2003 11:37:18 AM, Version: 3.208.34
EM                 : 10/14/2001 9:20:42 PM, Version: 1.00.0001
Delwaq1            : 4/3/2002 2:21:08 PM, Version:
Delwaq1p           : 4/3/2002 2:22:46 PM, Version:
Delwaq2            : 1/30/2003 1:01:20 PM, Version:
Waterbal           : 1/10/2003 11:22:18 AM, Version: 2.00.02
Simulate           : 11/7/2002 4:46:30 PM, Version: 2.06.0078

SOBEKVersion   = Sobek Advanced Version 2.08.002
```

10.7. Boundary Condition for return period of 2 years

Date	Time	Bicol	Bay	Naga	Libmanan
01/01/2000	00:00:00	0.00	0.00	0.00	0.00
01/01/2000	12:15:00	61.76	0.00	7.59	9.31
01/01/2000	12:30:00	61.76	0.20	11.44	21.99
01/01/2000	12:45:00	61.90	0.40	11.59	21.83
01/01/2000	13:00:00	60.68	0.46	11.89	22.85
01/01/2000	13:15:00	59.70	0.56	12.03	10.08
01/01/2000	13:30:00	58.90	0.68	11.56	-42.13
01/01/2000	13:45:00	58.24	0.76	4.59	-43.36
01/01/2000	14:00:00	57.65	0.82	9.10	-38.10
01/01/2000	14:15:00	56.99	0.91	10.08	-38.06
01/01/2000	14:30:00	55.47	0.97	8.66	-43.04
01/01/2000	14:45:00	50.99	0.98	8.67	-39.83
01/01/2000	15:00:00	46.44	0.99	9.35	-33.14
01/01/2000	15:15:00	41.88	0.99	9.46	-28.55
01/01/2000	15:30:00	38.12	0.97	9.40	-14.89
01/01/2000	15:45:00	34.34	0.94	9.77	11.43
01/01/2000	16:00:00	30.18	0.90	10.43	29.52
01/01/2000	16:15:00	27.50	0.83	10.96	36.63
01/01/2000	16:30:00	25.44	0.75	11.67	44.42
01/01/2000	16:45:00	24.11	0.66	12.30	52.34
01/01/2000	17:00:00	24.29	0.57	13.22	64.29
01/01/2000	17:15:00	26.55	0.49	14.49	68.24
01/01/2000	17:30:00	30.56	0.41	14.60	68.32
01/01/2000	17:45:00	36.22	0.32	14.49	66.40
01/01/2000	18:00:00	41.53	0.22	14.08	64.32
01/01/2000	18:15:00	45.56	0.12	13.70	61.54
01/01/2000	18:30:00	48.00	0.02	13.77	59.30
01/01/2000	18:45:00	49.49	-0.07	13.76	57.70
01/01/2000	19:00:00	50.30	-0.16	13.75	56.82
01/01/2000	19:15:00	50.61	-0.24	13.74	55.70
01/01/2000	19:30:00	50.70	-0.33	13.71	54.37
01/01/2000	19:45:00	50.82	-0.42	13.64	52.80
01/01/2000	20:00:00	50.93	-0.51	13.60	51.10
01/01/2000	20:15:00	50.98	-0.59	13.52	49.50
01/01/2000	20:30:00	51.03	-0.66	13.47	48.03
01/01/2000	20:45:00	51.10	-0.71	13.42	46.71
01/01/2000	21:00:00	51.15	-0.75	13.39	45.46
01/01/2000	21:15:00	51.09	-0.78	13.34	44.28
01/01/2000	21:30:00	51.04	-0.80	13.28	43.10
01/01/2000	21:45:00	50.95	-0.81	13.24	41.91

Date	Time	Bicol	Bay	Naga	Libmanan
01/01/2000	22:00:00	50.89	-0.76	13.20	40.75
01/01/2000	22:15:00	50.85	-0.69	13.15	39.66
01/01/2000	22:30:00	51.06	-0.60	13.10	38.72
01/01/2000	22:45:00	50.99	-0.52	13.07	37.84
01/01/2000	23:00:00	50.78	-0.43	13.04	36.98
01/01/2000	23:15:00	50.54	-0.33	13.01	35.95
01/01/2000	23:30:00	50.33	-0.22	12.96	34.06
01/01/2000	23:45:00	50.15	-0.08	12.91	28.60
02/01/2000	00:00:00	49.96	0.06	12.84	17.94
02/01/2000	00:15:00	49.75	0.19	12.72	5.70
02/01/2000	00:30:00	49.47	0.31	12.43	-2.04
02/01/2000	00:45:00	49.18	0.42	11.69	-7.38
02/01/2000	01:00:00	48.84	0.54	10.75	-13.03
02/01/2000	01:15:00	48.43	0.66	10.30	-17.74
02/01/2000	01:30:00	47.83	0.78	10.49	-22.41
02/01/2000	01:45:00	46.81	0.88	10.44	-27.40
02/01/2000	02:00:00	45.04	0.96	10.20	-32.61
02/01/2000	02:15:00	42.22	1.01	9.92	-36.66
02/01/2000	02:30:00	38.27	1.06	9.88	-37.69
02/01/2000	02:45:00	33.91	1.11	9.96	-32.45
02/01/2000	03:00:00	29.52	1.13	10.38	-20.63
02/01/2000	03:15:00	24.80	1.14	10.82	-0.76
02/01/2000	03:30:00	19.58	1.11	10.79	18.55
02/01/2000	03:45:00	15.32	1.06	11.20	27.74
02/01/2000	04:00:00	12.45	1.00	11.90	28.61
02/01/2000	04:15:00	9.73	0.93	12.46	31.21
02/01/2000	04:30:00	8.70	0.86	12.82	38.92
02/01/2000	04:45:00	9.76	0.77	13.08	53.88
02/01/2000	05:00:00	12.40	0.66	13.75	67.77
02/01/2000	05:15:00	15.35	0.54	14.95	74.34
02/01/2000	05:30:00	18.17	0.42	16.42	85.09
02/01/2000	05:45:00	23.15	0.31	17.08	90.61
02/01/2000	06:00:00	29.95	0.20	15.92	88.03
02/01/2000	06:15:00	37.85	0.10	15.78	85.49
02/01/2000	06:30:00	44.46	0.00	15.61	83.21
02/01/2000	06:45:00	48.13	-0.12	15.59	80.65
02/01/2000	07:00:00	50.12	-0.24	15.63	77.75
02/01/2000	07:15:00	51.63	-0.35	15.55	74.95
02/01/2000	07:30:00	53.09	-0.46	15.43	72.46
02/01/2000	07:45:00	54.14	-0.56	15.39	70.38

Boundary Condition for return period of 2 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
02/01/2000	08:00:00	54.98	-0.64	15.33	68.45
02/01/2000	08:15:00	55.55	-0.73	15.23	66.66
02/01/2000	08:30:00	55.81	-0.81	15.14	64.87
02/01/2000	08:45:00	56.07	-0.88	15.05	63.12
02/01/2000	09:00:00	56.20	-0.95	14.96	61.50
02/01/2000	09:15:00	56.27	-1.00	14.86	60.05
02/01/2000	09:30:00	56.34	-1.04	14.76	58.72
02/01/2000	09:45:00	56.39	-1.07	14.68	57.52
02/01/2000	10:00:00	56.43	-1.09	14.60	56.47
02/01/2000	10:15:00	56.43	-1.10	14.53	55.58
02/01/2000	10:30:00	56.55	-1.08	14.47	54.90
02/01/2000	10:45:00	56.83	-1.01	14.42	54.40
02/01/2000	11:00:00	56.89	-0.92	14.39	54.05
02/01/2000	11:15:00	56.86	-0.82	14.37	53.86
02/01/2000	11:30:00	56.93	-0.72	14.34	53.82
02/01/2000	11:45:00	57.09	-0.61	14.33	53.90
02/01/2000	12:00:00	57.19	-0.50	14.35	54.08
02/01/2000	12:15:00	57.30	-0.38	14.37	54.22
02/01/2000	12:30:00	57.38	-0.24	14.41	53.89
02/01/2000	12:45:00	57.46	-0.09	14.48	52.27
02/01/2000	13:00:00	57.55	0.05	14.56	48.04
02/01/2000	13:15:00	57.71	0.18	14.60	40.60
02/01/2000	13:30:00	57.92	0.31	14.53	34.94
02/01/2000	13:45:00	58.21	0.43	14.17	32.32
02/01/2000	14:00:00	58.53	0.57	13.74	30.54
02/01/2000	14:15:00	58.87	0.69	13.82	29.32
02/01/2000	14:30:00	59.08	0.79	14.11	29.59
02/01/2000	14:45:00	59.05	0.87	14.48	30.85
02/01/2000	15:00:00	58.51	0.92	14.82	34.64
02/01/2000	15:15:00	57.29	0.97	15.39	43.96
02/01/2000	15:30:00	55.20	1.00	16.61	60.23
02/01/2000	15:45:00	52.72	1.02	17.83	83.36
02/01/2000	16:00:00	50.01	1.02	19.03	109.08
02/01/2000	16:15:00	48.31	0.99	20.98	137.64
02/01/2000	16:30:00	46.77	0.94	22.97	167.43
02/01/2000	16:45:00	46.63	0.88	24.93	192.15
02/01/2000	17:00:00	48.23	0.83	26.71	214.73
02/01/2000	17:15:00	52.89	0.77	28.99	238.36
02/01/2000	17:30:00	58.98	0.69	31.56	265.20
02/01/2000	17:45:00	65.60	0.61	34.51	293.39
02/01/2000	18:00:00	73.22	0.52	37.66	321.21
02/01/2000	18:15:00	82.52	0.43	39.93	346.10
02/01/2000	18:30:00	94.12	0.34	42.08	376.37
02/01/2000	18:45:00	107.89	0.26	44.70	403.74
02/01/2000	19:00:00	119.31	0.17	47.53	428.79
02/01/2000	19:15:00	129.38	0.08	50.61	453.36
02/01/2000	19:30:00	138.77	-0.02	53.82	478.98
02/01/2000	19:45:00	147.58	-0.13	57.11	503.25
02/01/2000	20:00:00	150.05	-0.24	60.38	527.95
02/01/2000	20:15:00	147.53	-0.33	63.65	553.24
02/01/2000	20:30:00	152.81	-0.41	67.05	577.26
02/01/2000	20:45:00	157.76	-0.48	70.49	600.80
02/01/2000	21:00:00	162.45	-0.55	73.93	623.10
02/01/2000	21:15:00	167.17	-0.60	77.36	644.52
02/01/2000	21:30:00	171.57	-0.65	80.77	663.99
02/01/2000	21:45:00	175.58	-0.69	84.12	682.16
02/01/2000	22:00:00	179.90	-0.70	87.44	699.67
02/01/2000	22:15:00	184.66	-0.70	90.66	717.73
02/01/2000	22:30:00	189.91	-0.67	93.80	734.65
02/01/2000	22:45:00	195.46	-0.63	96.80	749.78
02/01/2000	23:00:00	201.02	-0.58	99.72	763.20
02/01/2000	23:15:00	206.75	-0.51	102.47	775.53
02/01/2000	23:30:00	212.41	-0.41	105.05	787.33
02/01/2000	23:45:00	218.37	-0.31	107.44	798.76
03/01/2000	00:00:00	224.91	-0.19	109.64	809.88
03/01/2000	00:15:00	232.88	-0.08	111.63	820.75
03/01/2000	00:30:00	241.12	0.02	113.43	831.22
03/01/2000	00:45:00	249.55	0.13	115.01	841.33
03/01/2000	01:00:00	256.04	0.26	116.39	850.97
03/01/2000	01:15:00	260.23	0.40	117.54	860.26
03/01/2000	01:30:00	262.87	0.53	118.53	869.12
03/01/2000	01:45:00	264.63	0.65	119.30	877.56
03/01/2000	02:00:00	265.97	0.76	119.86	885.15
03/01/2000	02:15:00	266.30	0.86	120.22	892.50
03/01/2000	02:30:00	266.35	0.96	120.27	899.45
03/01/2000	02:45:00	266.46	1.06	120.18	906.03
03/01/2000	03:00:00	266.51	1.13	120.53	911.98
03/01/2000	03:15:00	266.47	1.18	120.16	917.64
03/01/2000	03:30:00	266.47	1.20	119.85	922.56
03/01/2000	03:45:00	266.39	1.20	119.29	926.65
03/01/2000	04:00:00	266.05	1.19	118.61	930.18
03/01/2000	04:15:00	265.33	1.17	117.72	933.34
03/01/2000	04:30:00	264.40	1.12	116.62	935.58
03/01/2000	04:45:00	263.32	1.03	115.45	937.51
03/01/2000	05:00:00	262.05	0.96	114.08	939.06
03/01/2000	05:15:00	260.63	1.10	112.63	940.28
03/01/2000	05:30:00	259.01	1.10	111.07	940.81
03/01/2000	05:45:00	257.20	1.22	109.43	940.93
03/01/2000	06:00:00	255.29	1.41	107.68	940.32
03/01/2000	06:15:00	253.33	1.44	105.85	939.29
03/01/2000	06:30:00	251.38	1.48	103.93	937.61
03/01/2000	06:45:00	249.44	1.57	101.95	935.63
03/01/2000	07:00:00	247.54	1.58	99.91	933.04
03/01/2000	07:15:00	245.66	1.56	97.82	929.78
03/01/2000	07:30:00	243.79	1.54	95.62	925.81
03/01/2000	07:45:00	241.87	1.49	93.41	921.84
03/01/2000	08:00:00	239.87	1.40	91.19	917.41
03/01/2000	08:15:00	237.86	1.32	88.96	912.67
03/01/2000	08:30:00	235.88	1.20	86.72	907.67
03/01/2000	08:45:00	233.95	1.07	84.44	902.69

Boundary Condition for return period of 2 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
03/01/2000	09:00:00	232.06	0.94	82.36	897.30
03/01/2000	09:15:00	230.24	0.81	80.32	891.73
03/01/2000	09:30:00	228.49	0.68	78.20	885.79
03/01/2000	09:45:00	226.81	0.56	76.22	879.66
03/01/2000	10:00:00	225.08	0.45	74.29	873.08
03/01/2000	10:15:00	223.16	0.36	72.45	866.35
03/01/2000	10:30:00	221.39	0.28	70.68	859.02
03/01/2000	10:45:00	219.77	0.21	68.97	851.30
03/01/2000	11:00:00	218.23	0.16	67.33	843.04
03/01/2000	11:15:00	216.66	0.11	65.76	834.59
03/01/2000	11:30:00	215.13	0.09	64.28	825.73
03/01/2000	11:45:00	213.66	0.06	62.81	816.62
03/01/2000	12:00:00	212.06	0.05	61.40	806.97
03/01/2000	12:15:00	210.60	0.04	60.03	797.50
03/01/2000	12:30:00	209.16	0.04	58.73	788.50
03/01/2000	12:45:00	207.59	0.04	57.47	778.42
03/01/2000	13:00:00	205.84	0.04	56.15	767.69
03/01/2000	13:15:00	204.41	0.03	54.94	756.68
03/01/2000	13:30:00	209.96	-0.11	53.86	745.40
03/01/2000	13:45:00	210.52	-0.16	52.73	733.97
03/01/2000	14:00:00	209.63	0.36	51.54	722.26
03/01/2000	14:15:00	209.15	0.30	50.46	710.54
03/01/2000	14:30:00	208.59	0.43	49.43	698.99
03/01/2000	14:45:00	208.06	0.58	48.45	687.50
03/01/2000	15:00:00	207.53	0.72	47.46	674.13
03/01/2000	15:15:00	206.99	0.75	46.14	662.33
03/01/2000	15:30:00	206.44	0.85	45.48	650.09
03/01/2000	15:45:00	205.91	0.95	44.48	637.56
03/01/2000	16:00:00	205.35	0.96	43.48	625.18
03/01/2000	16:15:00	204.86	0.95	42.64	613.79
03/01/2000	16:30:00	204.36	0.97	42.08	602.35
03/01/2000	16:45:00	203.85	0.95	41.20	591.02
03/01/2000	17:00:00	203.31	0.91	40.84	580.15
03/01/2000	17:15:00	202.77	0.89	40.31	570.02
03/01/2000	17:30:00	202.22	0.86	39.75	560.53
03/01/2000	17:45:00	201.65	0.79	39.32	551.19
03/01/2000	18:00:00	201.11	0.72	38.95	542.28
03/01/2000	18:15:00	200.61	0.66	38.54	533.46
03/01/2000	18:30:00	200.16	0.59	38.17	524.80
03/01/2000	18:45:00	199.76	0.53	37.83	516.27
03/01/2000	19:00:00	199.43	0.46	37.51	508.05
03/01/2000	19:15:00	199.14	0.37	37.21	501.65
03/01/2000	19:30:00	198.88	0.27	37.00	496.09
03/01/2000	19:45:00	198.68	0.16	36.75	489.96
03/01/2000	20:00:00	198.50	0.05	36.43	483.61
03/01/2000	20:15:00	198.37	-0.04	36.15	477.52
03/01/2000	20:30:00	198.28	-0.14	35.97	471.11
03/01/2000	20:45:00	198.22	-0.24	35.73	464.48
03/01/2000	21:00:00	198.17	-0.33	35.47	457.92
03/01/2000	21:15:00	198.12	-0.42	35.22	451.33

Date	Time	Bicol	Bay	Naga	Libmanan
03/01/2000	21:30:00	198.08	-0.50	34.95	444.82
03/01/2000	21:45:00	198.04	-0.55	34.68	438.39
03/01/2000	22:00:00	198.03	-0.60	34.50	432.17
03/01/2000	22:15:00	198.01	-0.63	34.88	426.73
03/01/2000	22:30:00	197.99	-0.64	34.28	421.53
03/01/2000	22:45:00	198.10	-0.64	33.91	415.75
03/01/2000	23:00:00	198.19	-0.64	33.58	409.89
03/01/2000	23:15:00	198.13	-0.61	33.56	404.51
03/01/2000	23:30:00	198.05	-0.55	33.32	401.86
03/01/2000	23:45:00	198.04	-0.48	33.07	395.33
04/01/2000	00:00:00	198.30	-0.40	32.89	389.16
04/01/2000	00:15:00	198.35	-0.33	32.70	383.77
04/01/2000	00:30:00	198.16	-0.25	32.52	378.92
04/01/2000	00:45:00	198.00	-0.16	32.31	374.14
04/01/2000	01:00:00	197.83	-0.05	32.09	369.32
04/01/2000	01:15:00	197.65	0.07	31.88	364.47
04/01/2000	01:30:00	197.46	0.20	31.67	359.76
04/01/2000	01:45:00	197.27	0.31	31.45	354.88
04/01/2000	02:00:00	197.07	0.42	31.18	349.54
04/01/2000	02:15:00	196.87	0.55	30.84	343.45
04/01/2000	02:30:00	196.65	0.69	30.39	336.52
04/01/2000	02:45:00	196.42	0.82	29.77	329.74
04/01/2000	03:00:00	196.15	0.94	29.14	322.12
04/01/2000	03:15:00	195.83	1.03	28.74	313.00
04/01/2000	03:30:00	195.41	1.09	28.27	304.71
04/01/2000	03:45:00	194.81	1.14	28.00	300.43
04/01/2000	04:00:00	194.19	1.18	27.90	297.97
04/01/2000	04:15:00	193.55	1.20	29.45	293.79
04/01/2000	04:30:00	192.75	1.21	28.90	288.58
04/01/2000	04:45:00	192.08	1.19	28.23	285.83
04/01/2000	05:00:00	191.62	1.14	28.22	283.21
04/01/2000	05:15:00	191.04	1.07	27.95	280.26
04/01/2000	05:30:00	190.49	1.00	27.70	276.99
04/01/2000	05:45:00	189.91	0.93	27.58	275.00
04/01/2000	06:00:00	189.30	0.87	27.30	275.05
04/01/2000	06:15:00	188.68	0.78	27.13	275.85
04/01/2000	06:30:00	188.10	0.69	27.13	275.42
04/01/2000	06:45:00	187.55	0.58	27.02	273.81
04/01/2000	07:00:00	187.03	0.48	26.92	270.98
04/01/2000	07:15:00	186.55	0.37	26.71	267.87
04/01/2000	07:30:00	186.17	0.27	26.51	266.08
04/01/2000	07:45:00	185.87	0.15	26.10	266.49
04/01/2000	08:00:00	185.63	0.03	25.90	266.13
04/01/2000	08:15:00	185.39	-0.10	25.96	262.31
04/01/2000	08:30:00	185.16	-0.24	25.50	258.25
04/01/2000	08:45:00	184.91	-0.37	25.43	254.52
04/01/2000	09:00:00	184.67	-0.47	24.75	250.75
04/01/2000	09:15:00	184.45	-0.57	24.46	247.41
04/01/2000	09:30:00	184.22	-0.67	25.18	243.88
04/01/2000	09:45:00	183.97	-0.74	24.29	239.98

Boundary Condition for return period of 2 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	10:00:00	183.89	-0.80	23.73	235.96
04/01/2000	10:15:00	183.91	-0.86	23.38	231.75
04/01/2000	10:30:00	183.73	-0.91	22.98	227.33
04/01/2000	10:45:00	183.55	-0.94	22.60	222.98
04/01/2000	11:00:00	183.17	-0.96	22.26	218.76
04/01/2000	11:15:00	182.75	-0.98	21.95	214.66
04/01/2000	11:30:00	182.30	-0.98	21.59	210.70
04/01/2000	11:45:00	181.89	-0.98	21.29	206.86
04/01/2000	12:00:00	181.51	-0.96	20.99	203.19
04/01/2000	12:15:00	181.16	-0.91	20.71	199.63
04/01/2000	12:30:00	180.83	-0.84	20.45	196.16
04/01/2000	12:45:00	180.50	-0.76	20.20	192.79
04/01/2000	13:00:00	180.18	-0.68	19.96	189.55
04/01/2000	13:15:00	179.86	-0.60	19.70	186.38
04/01/2000	13:30:00	179.55	-0.51	19.47	183.24
04/01/2000	13:45:00	179.24	-0.39	19.24	180.14
04/01/2000	14:00:00	178.94	-0.26	19.02	177.07
04/01/2000	14:15:00	178.64	-0.12	18.80	174.00
04/01/2000	14:30:00	178.37	0.02	18.58	170.83
04/01/2000	14:45:00	178.13	0.15	18.35	166.95
04/01/2000	15:00:00	177.90	0.28	18.08	160.80
04/01/2000	15:15:00	177.59	0.41	17.66	152.57
04/01/2000	15:30:00	177.23	0.54	17.05	143.90
04/01/2000	15:45:00	176.93	0.65	16.32	134.53
04/01/2000	16:00:00	176.64	0.73	15.84	123.90
04/01/2000	16:15:00	176.33	0.78	15.44	113.73
04/01/2000	16:30:00	175.97	0.81	15.35	107.04
04/01/2000	16:45:00	175.51	0.84	15.51	107.72
04/01/2000	17:00:00	174.91	0.86	16.06	115.23
04/01/2000	17:15:00	174.17	0.86	16.19	125.03
04/01/2000	17:30:00	173.02	0.85	16.57	131.66
04/01/2000	17:45:00	172.18	0.81	16.67	134.38
04/01/2000	18:00:00	171.50	0.77	16.78	136.56
04/01/2000	18:15:00	170.81	0.73	17.07	139.43
04/01/2000	18:30:00	170.19	0.70	17.52	143.65
04/01/2000	18:45:00	169.69	0.67	17.89	146.03
04/01/2000	19:00:00	169.39	0.62	17.91	146.91
04/01/2000	19:15:00	169.28	0.55	17.86	145.83
04/01/2000	19:30:00	169.37	0.47	17.80	144.05
04/01/2000	19:45:00	169.49	0.39	17.64	142.69
04/01/2000	20:00:00	169.58	0.30	17.60	142.09
04/01/2000	20:15:00	169.64	0.21	17.69	142.26
04/01/2000	20:30:00	169.66	0.11	17.76	142.42
04/01/2000	20:45:00	169.82	0.00	17.82	142.12
04/01/2000	21:00:00	169.96	-0.11	17.86	141.22

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	21:15:00	170.00	-0.23	17.89	139.91
04/01/2000	21:30:00	170.05	-0.34	17.89	138.44
04/01/2000	21:45:00	170.05	-0.43	17.92	136.88
04/01/2000	22:00:00	170.04	-0.50	17.89	135.35
04/01/2000	22:15:00	170.05	-0.55	17.88	133.55
04/01/2000	22:30:00	170.07	-0.61	17.88	131.49
04/01/2000	22:45:00	170.11	-0.63	17.85	129.28
04/01/2000	23:00:00	170.30	-0.66	17.85	126.96
04/01/2000	23:15:00	170.73	-0.65	17.79	124.55
04/01/2000	23:30:00	171.93	-0.61	17.73	122.17
04/01/2000	23:45:00	172.14	-0.56	17.72	119.84
05/01/2000	00:00:00	172.08	-0.52	17.66	117.58
05/01/2000	00:15:00	171.94	-0.48	17.57	115.39
05/01/2000	00:30:00	171.68	-0.43	17.42	113.17
05/01/2000	00:45:00	171.36	-0.36	17.46	110.83
05/01/2000	01:00:00	171.01	-0.28	17.34	108.43
05/01/2000	01:15:00	170.66	-0.19	17.91	106.10
05/01/2000	01:30:00	170.35	-0.10	17.09	103.69
05/01/2000	01:45:00	170.03	-0.02	16.99	100.19
05/01/2000	02:00:00	169.69	0.08	16.80	93.34
05/01/2000	02:15:00	169.31	0.19	16.54	85.34
05/01/2000	02:30:00	168.92	0.33	16.13	78.33
05/01/2000	02:45:00	168.49	0.47	15.63	73.31
05/01/2000	03:00:00	168.04	0.60	15.18	67.58
05/01/2000	03:15:00	167.58	0.71	14.63	58.36
05/01/2000	03:30:00	167.06	0.82	14.02	44.78
05/01/2000	03:45:00	166.48	0.91	13.48	31.68
05/01/2000	04:00:00	165.78	1.00	13.03	26.07
05/01/2000	04:15:00	164.91	1.07	13.20	28.28
05/01/2000	04:30:00	163.76	1.12	13.37	36.26
05/01/2000	04:45:00	162.23	1.13	13.63	42.36
05/01/2000	05:00:00	160.23	1.12	13.62	51.31
05/01/2000	05:15:00	157.97	1.10	13.33	61.90
05/01/2000	05:30:00	155.98	1.07	13.84	68.01
05/01/2000	05:45:00	154.20	1.04	14.40	70.61
05/01/2000	06:00:00	152.63	1.00	14.43	77.36
05/01/2000	06:15:00	151.48	0.95	14.30	84.74
05/01/2000	06:30:00	150.87	0.88	14.32	90.41
05/01/2000	06:45:00	151.49	0.80	14.29	94.24
05/01/2000	07:00:00	152.10	0.72	14.69	96.33
05/01/2000	07:15:00	152.55	0.65	14.88	98.38
05/01/2000	07:30:00	153.39	0.57	15.35	104.29
05/01/2000	07:45:00	154.01	0.47	15.66	108.07
05/01/2000	08:00:00	154.74	0.36	15.55	107.60
05/01/2000	08:15:00	155.63	0.23	15.27	108.16

Boundary Condition for return period of 2 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	08:30:00	156.29	0.09	15.05	106.50
05/01/2000	08:45:00	156.96	-0.04	15.04	104.71
05/01/2000	09:00:00	157.61	-0.17	14.94	102.82
05/01/2000	09:15:00	158.00	-0.29	14.83	101.03
05/01/2000	09:30:00	158.16	-0.41	14.75	99.06
05/01/2000	09:45:00	158.38	-0.53	14.65	96.88
05/01/2000	10:00:00	158.59	-0.63	14.61	94.41
05/01/2000	10:15:00	158.83	-0.72	14.60	91.91
05/01/2000	10:30:00	159.08	-0.80	14.83	89.38
05/01/2000	10:45:00	159.49	-0.86	15.31	86.85
05/01/2000	11:00:00	160.17	-0.90	14.48	84.30
05/01/2000	11:15:00	161.02	-0.94	14.55	81.77
05/01/2000	11:30:00	161.28	-0.97	14.44	79.32
05/01/2000	11:45:00	161.26	-0.98	14.36	76.95
05/01/2000	12:00:00	161.18	-0.99	14.24	74.68
05/01/2000	12:15:00	161.05	-0.97	14.13	72.48
05/01/2000	12:30:00	160.81	-0.93	14.04	70.39
05/01/2000	12:45:00	160.54	-0.89	13.93	68.41
05/01/2000	13:00:00	160.30	-0.85	13.81	66.52
05/01/2000	13:15:00	160.09	-0.82	13.76	64.70
05/01/2000	13:30:00	159.89	-0.76	13.67	63.03
05/01/2000	13:45:00	159.72	-0.68	13.52	61.41
05/01/2000	14:00:00	159.58	-0.58	13.40	59.82
05/01/2000	14:15:00	159.45	-0.49	13.29	58.27
05/01/2000	14:30:00	159.27	-0.39	13.23	56.75
05/01/2000	14:45:00	159.06	-0.28	13.21	54.88
05/01/2000	15:00:00	158.87	-0.15	13.13	51.39
05/01/2000	15:15:00	158.67	-0.01	13.01	45.42
05/01/2000	15:30:00	158.47	0.13	12.84	36.14
05/01/2000	15:45:00	158.25	0.26	12.59	26.24
05/01/2000	16:00:00	158.03	0.37	12.15	15.27
05/01/2000	16:15:00	157.78	0.46	11.49	1.04

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	16:30:00	157.51	0.53	10.72	-10.52
05/01/2000	16:45:00	157.19	0.60	10.24	-14.62
05/01/2000	17:00:00	156.81	0.65	10.23	-14.50
05/01/2000	17:15:00	156.30	0.69	10.35	-12.59
05/01/2000	17:30:00	155.58	0.70	10.53	-7.97
05/01/2000	17:45:00	154.62	0.69	10.55	-0.82
05/01/2000	18:00:00	153.43	0.68	10.75	9.79
05/01/2000	18:15:00	152.11	0.68	11.05	25.10
05/01/2000	18:30:00	150.77	0.68	11.46	41.79
05/01/2000	18:45:00	149.42	0.68	12.02	54.61
05/01/2000	19:00:00	148.24	0.66	12.45	58.21
05/01/2000	19:15:00	147.67	0.63	12.44	55.49
05/01/2000	19:30:00	147.76	0.58	12.46	51.63
05/01/2000	19:45:00	148.19	0.54	12.58	49.87
05/01/2000	20:00:00	148.79	0.49	12.81	52.01
05/01/2000	20:15:00	149.29	0.43	12.98	55.14
05/01/2000	20:30:00	149.67	0.35	13.01	56.59
05/01/2000	20:45:00	150.05	0.25	13.00	56.70
05/01/2000	21:00:00	150.45	0.14	13.00	56.48
05/01/2000	21:15:00	150.83	0.02	13.00	57.58
05/01/2000	21:30:00	151.12	-0.08	13.06	59.44
05/01/2000	21:45:00	151.37	-0.18	13.14	60.91
05/01/2000	22:00:00	151.58	-0.27	13.20	61.35
05/01/2000	22:15:00	151.77	-0.36	13.23	60.92
05/01/2000	22:30:00	151.95	-0.44	13.27	59.87
05/01/2000	22:45:00	152.14	-0.50	13.23	58.36
05/01/2000	23:00:00	152.31	-0.55	13.22	56.62
05/01/2000	23:15:00	152.46	-0.57	13.19	54.82
05/01/2000	23:30:00	152.61	-0.56	13.18	53.05
05/01/2000	23:45:00	152.74	-0.53	13.07	51.36
06/01/2000	00:00:00	152.87	-0.51	13.03	49.65

10.8. Boundary Condition for return period of 5 years

Date	Time	Bicol	Bay	Naga	Libmanan
01/01/2000	00:00:00	0	0	0	0
01/01/2000	12:15:00	61.77	0	7.65	9.31
01/01/2000	12:30:00	61.78	0.2	11.45	22.02
01/01/2000	12:45:00	61.92	0.4	11.59	21.87
01/01/2000	13:00:00	60.71	0.46	11.89	22.87
01/01/2000	13:15:00	59.74	0.56	12.03	10.14
01/01/2000	13:30:00	58.95	0.68	11.58	-42.07
01/01/2000	13:45:00	58.3	0.76	4.75	-43.27
01/01/2000	14:00:00	57.73	0.82	9.14	-37.9
01/01/2000	14:15:00	57.08	0.91	10.12	-37.91
01/01/2000	14:30:00	55.58	0.97	8.72	-42.83
01/01/2000	14:45:00	51.11	0.98	8.73	-39.55
01/01/2000	15:00:00	46.58	0.99	9.41	-32.77
01/01/2000	15:15:00	42.05	0.99	9.53	-28.1
01/01/2000	15:30:00	38.32	0.97	9.46	-14.25
01/01/2000	15:45:00	34.57	0.94	9.84	12.18
01/01/2000	16:00:00	30.46	0.9	10.5	30.27
01/01/2000	16:15:00	27.85	0.83	11.03	37.33
01/01/2000	16:30:00	25.83	0.75	11.74	45.07
01/01/2000	16:45:00	24.55	0.66	12.38	53
01/01/2000	17:00:00	24.83	0.57	13.29	64.95
01/01/2000	17:15:00	27.18	0.49	14.53	69.14
01/01/2000	17:30:00	31.28	0.41	14.64	69.3
01/01/2000	17:45:00	36.98	0.32	14.53	67.55
01/01/2000	18:00:00	42.26	0.22	14.23	65.61
01/01/2000	18:15:00	46.36	0.12	13.83	63
01/01/2000	18:30:00	48.86	0.02	13.92	60.94
01/01/2000	18:45:00	50.43	-0.07	13.93	59.54
01/01/2000	19:00:00	51.34	-0.16	13.96	58.83
01/01/2000	19:15:00	51.82	-0.24	13.97	57.93
01/01/2000	19:30:00	52	-0.33	13.97	56.81
01/01/2000	19:45:00	52.22	-0.42	13.94	55.48
01/01/2000	20:00:00	52.43	-0.51	13.94	54.05
01/01/2000	20:15:00	52.6	-0.59	13.89	52.73
01/01/2000	20:30:00	52.76	-0.66	13.88	51.56
01/01/2000	20:45:00	52.94	-0.71	13.88	50.52
01/01/2000	21:00:00	53.13	-0.75	13.89	49.56
01/01/2000	21:15:00	53.25	-0.78	13.9	48.7
01/01/2000	21:30:00	53.26	-0.8	13.9	47.9
01/01/2000	21:45:00	53.29	-0.8	13.91	47.13

Date	Time	Bicol	Bay	Naga	Libmanan
01/01/2000	22:00:00	53.39	-0.76	13.92	46.41
01/01/2000	22:15:00	53.53	-0.69	13.94	45.79
01/01/2000	22:30:00	53.89	-0.6	13.96	45.29
01/01/2000	22:45:00	54.03	-0.52	14	44.9
01/01/2000	23:00:00	54.09	-0.43	14.04	44.58
01/01/2000	23:15:00	54.01	-0.33	14.08	44.18
01/01/2000	23:30:00	53.95	-0.21	14.12	43.23
01/01/2000	23:45:00	53.94	-0.08	14.14	40.15
02/01/2000	00:00:00	53.94	0.06	14.16	33.38
02/01/2000	00:15:00	53.94	0.19	14.13	23.69
02/01/2000	00:30:00	53.94	0.31	13.97	13.12
02/01/2000	00:45:00	53.92	0.42	13.41	5.82
02/01/2000	01:00:00	53.8	0.54	12.55	1.83
02/01/2000	01:15:00	53.61	0.66	12.06	-1.74
02/01/2000	01:30:00	53.26	0.78	12.37	-5.04
02/01/2000	01:45:00	52.53	0.88	12.42	-8.29
02/01/2000	02:00:00	51.1	0.96	12.31	-12.13
02/01/2000	02:15:00	48.66	1.01	12.07	-15.3
02/01/2000	02:30:00	45.06	1.07	12.13	-13
02/01/2000	02:45:00	41.13	1.11	12.28	-3.87
02/01/2000	03:00:00	36.84	1.14	13.1	12.31
02/01/2000	03:15:00	32.31	1.14	13.17	36.67
02/01/2000	03:30:00	28.46	1.11	13.36	51.92
02/01/2000	03:45:00	24.72	1.06	14	53.45
02/01/2000	04:00:00	22.51	1	14.73	50.41
02/01/2000	04:15:00	21.25	0.93	15.34	51.71
02/01/2000	04:30:00	20.46	0.86	15.46	59.6
02/01/2000	04:45:00	21.66	0.76	15.71	74.87
02/01/2000	05:00:00	24.86	0.66	16.56	87.87
02/01/2000	05:15:00	27.62	0.55	18.01	93.19
02/01/2000	05:30:00	29.04	0.43	18.61	101.22
02/01/2000	05:45:00	34	0.31	19.26	109.22
02/01/2000	06:00:00	41.18	0.21	18.45	108.32
02/01/2000	06:15:00	47.02	0.11	18.4	107.09
02/01/2000	06:30:00	51.45	0	18.65	105.11
02/01/2000	06:45:00	54.5	-0.11	18.53	103.05
02/01/2000	07:00:00	56.25	-0.23	18.38	100.68
02/01/2000	07:15:00	58.5	-0.35	18.26	98.23
02/01/2000	07:30:00	60.96	-0.45	18.19	96.15
02/01/2000	07:45:00	63.03	-0.55	18.18	94.37

Boundary Condition for return period of 5 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
02/01/2000	08:00:00	64.44	-0.64	18.12	92.76
02/01/2000	08:15:00	65.13	-0.72	18.04	91.45
02/01/2000	08:30:00	65.64	-0.8	17.92	90.13
02/01/2000	08:45:00	66.08	-0.87	17.84	88.83
02/01/2000	09:00:00	66.33	-0.94	17.72	87.66
02/01/2000	09:15:00	66.43	-0.99	17.64	86.66
02/01/2000	09:30:00	66.6	-1.03	17.55	85.86
02/01/2000	09:45:00	66.76	-1.06	17.49	85.27
02/01/2000	10:00:00	66.94	-1.08	17.43	84.92
02/01/2000	10:15:00	67.19	-1.09	17.39	84.81
02/01/2000	10:30:00	67.47	-1.07	17.37	84.97
02/01/2000	10:45:00	67.79	-1.01	17.37	85.37
02/01/2000	11:00:00	68.1	-0.91	17.39	86
02/01/2000	11:15:00	68.35	-0.81	17.44	86.86
02/01/2000	11:30:00	68.72	-0.71	17.49	87.95
02/01/2000	11:45:00	69.27	-0.6	17.57	89.23
02/01/2000	12:00:00	69.72	-0.49	17.69	90.68
02/01/2000	12:15:00	70.21	-0.37	17.83	92.23
02/01/2000	12:30:00	70.76	-0.23	18.02	93.94
02/01/2000	12:45:00	71.38	-0.08	18.26	95.52
02/01/2000	13:00:00	72.01	0.06	18.56	96.4
02/01/2000	13:15:00	72.75	0.19	18.87	96.53
02/01/2000	13:30:00	73.6	0.31	19.17	96.11
02/01/2000	13:45:00	74.63	0.44	19.22	95.58
02/01/2000	14:00:00	75.78	0.57	19.34	97.29
02/01/2000	14:15:00	77.1	0.7	19.85	101.52
02/01/2000	14:30:00	78.43	0.8	20.83	108.7
02/01/2000	14:45:00	79.72	0.87	21.98	119.38
02/01/2000	15:00:00	80.7	0.93	23.23	134.73
02/01/2000	15:15:00	81.38	0.97	24.78	157.87
02/01/2000	15:30:00	81.25	1.01	27.36	189.96
02/01/2000	15:45:00	80.63	1.03	29.76	224.86
02/01/2000	16:00:00	79.95	1.02	32.19	259.15
02/01/2000	16:15:00	81.17	0.99	35.48	293.46
02/01/2000	16:30:00	84.09	0.94	39.71	328.23
02/01/2000	16:45:00	88.68	0.88	43.5	366.13
02/01/2000	17:00:00	95.34	0.82	46.34	407.17
02/01/2000	17:15:00	108.47	0.76	50.11	449.99
02/01/2000	17:30:00	121.51	0.7	54.45	494.75
02/01/2000	17:45:00	133.99	0.62	59.04	540.46
02/01/2000	18:00:00	146.81	0.53	63.85	588.21
02/01/2000	18:15:00	160.19	0.44	68.96	636.18
02/01/2000	18:30:00	174.33	0.35	74.24	696.6
02/01/2000	18:45:00	189.1	0.27	79.75	749.83
02/01/2000	19:00:00	203.86	0.18	85.59	796.44
02/01/2000	19:15:00	218.72	0.09	91.61	841.26
02/01/2000	19:30:00	233.55	0	97.78	887.8
02/01/2000	19:45:00	248.12	-0.11	104.25	931.36
02/01/2000	20:00:00	249.52	-0.21	110.7	975.11
02/01/2000	20:15:00	240.43	-0.29	117.07	1018.92
02/01/2000	20:30:00	247.9	-0.37	123.6	1058.94
02/01/2000	20:45:00	254.8	-0.43	130.2	1097.29
02/01/2000	21:00:00	261.2	-0.49	136.8	1133.03
02/01/2000	21:15:00	268	-0.54	143.2	1166.2
02/01/2000	21:30:00	275.2	-0.58	149.6	1195.13
02/01/2000	21:45:00	281.8	-0.61	155.8	1221.16
02/01/2000	22:00:00	288.5	-0.62	161.9	1245.71
02/01/2000	22:15:00	295.3	-0.62	167.8	1271.25
02/01/2000	22:30:00	302.8	-0.6	173.4	1294.4
02/01/2000	22:45:00	310.9	-0.57	178.8	1313.77
02/01/2000	23:00:00	319.1	-0.54	184	1329.61
02/01/2000	23:15:00	327.8	-0.48	188.8	1343.18
02/01/2000	23:30:00	336.1	-0.39	193.3	1355.64
02/01/2000	23:45:00	345.2	-0.29	197.3	1367.52
03/01/2000	00:00:00	355.6	-0.17	201	1379.13
03/01/2000	00:15:00	369.3	-0.07	204.3	1390.36
03/01/2000	00:30:00	383.7	0.03	207.2	1401.15
03/01/2000	00:45:00	398.2	0.14	209.7	1411.53
03/01/2000	01:00:00	408.6	0.27	211.8	1421.38
03/01/2000	01:15:00	414.5	0.41	213.5	1430.81
03/01/2000	01:30:00	417.1	0.54	215	1439.75
03/01/2000	01:45:00	418	0.66	215.9	1448.21
03/01/2000	02:00:00	417.9	0.77	216.6	1455.9
03/01/2000	02:15:00	417.5	0.87	216.8	1463.23
03/01/2000	02:30:00	416.9	0.97	216.9	1469.89
03/01/2000	02:45:00	416.1	1.06	216.5	1476.02
03/01/2000	03:00:00	415.2	1.14	215.8	1481.16
03/01/2000	03:15:00	414.1	1.18	214.8	1485.66
03/01/2000	03:30:00	412.8	1.21	213.6	1489.08
03/01/2000	03:45:00	411.2	1.21	212	1491.88
03/01/2000	04:00:00	409.2	1.19	210.2	1493.67
03/01/2000	04:15:00	406.9	1.17	208.1	1494.86
03/01/2000	04:30:00	404.2	1.12	205.7	1495.08
03/01/2000	04:45:00	401.4	1.06	202.9	1494.77
03/01/2000	05:00:00	398.3	1.04	200	1493.52
03/01/2000	05:15:00	395.1	1.45	196.8	1491.73
03/01/2000	05:30:00	391.7	1.6	193.4	1489.06
03/01/2000	05:45:00	388.2	1.68	189.9	1485.9
03/01/2000	06:00:00	384.6	1.89	186.3	1481.86
03/01/2000	06:15:00	381	1.99	182.5	1477.36
03/01/2000	06:30:00	377.4	2.06	178.6	1472.09
03/01/2000	06:45:00	373.9	2.14	174.6	1466.43
03/01/2000	07:00:00	370.4	2.15	170.6	1460.12
03/01/2000	07:15:00	367	2.15	166.5	1453.48
03/01/2000	07:30:00	363.7	2.13	162.4	1446.15
03/01/2000	07:45:00	360.4	2.06	158.2	1438.55
03/01/2000	08:00:00	357.1	1.97	154	1430.3
03/01/2000	08:15:00	353.7	1.85	149.9	1421.82
03/01/2000	08:30:00	350.5	1.69	145.7	1412.81
03/01/2000	08:45:00	347.2	1.51	141.7	1403.53

Boundary Condition for return period of 5 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
03/01/2000	09:00:00	344.07	1.33	137.64	1393.63
03/01/2000	09:15:00	341.02	1.15	133.71	1383.43
03/01/2000	09:30:00	338.11	0.97	129.87	1372.63
03/01/2000	09:45:00	335.31	0.81	126.16	1361.54
03/01/2000	10:00:00	332.62	0.67	122.57	1349.78
03/01/2000	10:15:00	330.06	0.54	119.12	1337.63
03/01/2000	10:30:00	327.61	0.43	115.81	1324.71
03/01/2000	10:45:00	325.26	0.33	112.64	1311.33
03/01/2000	11:00:00	322.98	0.26	109.58	1297.25
03/01/2000	11:15:00	320.78	0.2	106.65	1282.87
03/01/2000	11:30:00	318.64	0.16	103.83	1267.85
03/01/2000	11:45:00	316.58	0.13	101.09	1252.43
03/01/2000	12:00:00	314.51	0.11	98.44	1236.36
03/01/2000	12:15:00	312.37	0.1	95.86	1220.13
03/01/2000	12:30:00	310.02	0.09	93.36	1203.36
03/01/2000	12:45:00	307.48	0.09	90.95	1186.23
03/01/2000	13:00:00	304.72	0.09	88.62	1168.61
03/01/2000	13:15:00	302.21	0.08	86.37	1150.71
03/01/2000	13:30:00	314.33	-0.03	84.21	1132.29
03/01/2000	13:45:00	315.83	-0.09	82.12	1113.65
03/01/2000	14:00:00	314.26	0.4	80.11	1094.82
03/01/2000	14:15:00	313.52	0.32	78.18	1076.19
03/01/2000	14:30:00	312.58	0.42	76.35	1057.69
03/01/2000	14:45:00	311.65	0.61	74.58	1039.27
03/01/2000	15:00:00	310.71	0.74	72.86	1020.85
03/01/2000	15:15:00	309.75	0.75	71.22	1002.73
03/01/2000	15:30:00	308.78	0.85	69.66	984.16
03/01/2000	15:45:00	307.81	0.97	68.17	965.94
03/01/2000	16:00:00	306.85	0.97	66.77	948.06
03/01/2000	16:15:00	306.09	0.95	65.43	930.3
03/01/2000	16:30:00	305.33	0.98	64.16	912.86
03/01/2000	16:45:00	304.59	0.96	62.95	895.54
03/01/2000	17:00:00	303.87	0.92	61.8	878.55
03/01/2000	17:15:00	303.17	0.9	60.69	861.79
03/01/2000	17:30:00	302.49	0.87	59.65	845.56
03/01/2000	17:45:00	301.85	0.8	58.66	829.69
03/01/2000	18:00:00	301.24	0.73	57.71	814.32
03/01/2000	18:15:00	300.67	0.68	56.81	799.06
03/01/2000	18:30:00	300.14	0.61	55.97	784.25
03/01/2000	18:45:00	299.65	0.54	55.15	769.63
03/01/2000	19:00:00	299.21	0.48	54.38	754.92
03/01/2000	19:15:00	298.82	0.39	53.63	743.17
03/01/2000	19:30:00	298.46	0.3	52.92	733.1
03/01/2000	19:45:00	298.16	0.19	52.24	722.72
03/01/2000	20:00:00	297.89	0.09	51.6	712.29
03/01/2000	20:15:00	297.67	0	51	701.73
03/01/2000	20:30:00	297.49	-0.09	50.4	691.29
03/01/2000	20:45:00	297.35	-0.18	49.83	680.94
03/01/2000	21:00:00	297.24	-0.26	49.29	670.93
03/01/2000	21:15:00	297.2	-0.34	48.77	661.06

Date	Time	Bicol	Bay	Naga	Libmanan
03/01/2000	21:30:00	297.2	-0.41	48.28	651.48
03/01/2000	21:45:00	297.2	-0.46	47.8	642.17
03/01/2000	22:00:00	297.3	-0.5	47.36	633.22
03/01/2000	22:15:00	297.3	-0.53	46.94	625.89
03/01/2000	22:30:00	297.4	-0.54	46.55	619.01
03/01/2000	22:45:00	297.5	-0.55	46.17	610.84
03/01/2000	23:00:00	297.7	-0.55	45.82	602.44
03/01/2000	23:15:00	297.8	-0.54	45.48	594.99
03/01/2000	23:30:00	297.9	-0.5	45.17	593.22
03/01/2000	23:45:00	298.1	-0.45	44.86	583.15
04/01/2000	00:00:00	298.3	-0.37	44.58	573.74
04/01/2000	00:15:00	298.5	-0.3	44.3	565.92
04/01/2000	00:30:00	298.7	-0.24	44.04	559.23
04/01/2000	00:45:00	298.9	-0.15	43.79	552.75
04/01/2000	01:00:00	299.1	-0.04	43.55	546.2
04/01/2000	01:15:00	299.3	0.08	43.32	539.59
04/01/2000	01:30:00	299.5	0.21	43.1	533.23
04/01/2000	01:45:00	299.7	0.32	42.88	526.82
04/01/2000	02:00:00	299.9	0.43	42.61	520.24
04/01/2000	02:15:00	300	0.56	42.36	513.58
04/01/2000	02:30:00	300.2	0.7	42.11	507.1
04/01/2000	02:45:00	300.3	0.83	41.85	501.27
04/01/2000	03:00:00	300.4	0.94	41.58	494.24
04/01/2000	03:15:00	300.5	1.03	41.31	486.87
04/01/2000	03:30:00	300.6	1.1	41.02	479.44
04/01/2000	03:45:00	300.6	1.15	40.73	471.81
04/01/2000	04:00:00	300.6	1.18	40.46	463.81
04/01/2000	04:15:00	300.6	1.21	40.13	455.54
04/01/2000	04:30:00	300.6	1.22	39.79	447.57
04/01/2000	04:45:00	300.5	1.19	39.44	440.28
04/01/2000	05:00:00	300.4	1.14	39.06	433.06
04/01/2000	05:15:00	300.3	1.07	38.67	426.06
04/01/2000	05:30:00	300.1	1	38.26	419.4
04/01/2000	05:45:00	299.9	0.94	37.83	413.16
04/01/2000	06:00:00	299.7	0.87	37.39	407.62
04/01/2000	06:15:00	299.4	0.79	36.94	402.71
04/01/2000	06:30:00	299.2	0.69	36.48	398.18
04/01/2000	06:45:00	298.9	0.59	36.01	393.56
04/01/2000	07:00:00	298.6	0.49	35.52	388.74
04/01/2000	07:15:00	298.2	0.38	35.04	383.73
04/01/2000	07:30:00	297.9	0.28	34.54	378.81
04/01/2000	07:45:00	297.5	0.17	34.05	374.01
04/01/2000	08:00:00	297.1	0.05	33.55	370.53
04/01/2000	08:15:00	296.7	-0.08	33.05	365.84
04/01/2000	08:30:00	296.4	-0.21	32.55	360.98
04/01/2000	08:45:00	296	-0.33	32.06	356.93
04/01/2000	09:00:00	295.7	-0.43	31.56	352.98
04/01/2000	09:15:00	295.3	-0.53	31.07	350.11
04/01/2000	09:30:00	294.9	-0.61	30.61	346.88
04/01/2000	09:45:00	294.6	-0.67	30.13	342.77

Boundary Condition for return period of 5 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	10:00:00	294.26	-0.73	29.66	338.31
04/01/2000	10:15:00	293.93	-0.78	29.2	333.36
04/01/2000	10:30:00	293.62	-0.82	28.75	327.88
04/01/2000	10:45:00	293.32	-0.85	28.31	322.38
04/01/2000	11:00:00	293.04	-0.87	27.89	317.04
04/01/2000	11:15:00	292.78	-0.88	27.48	311.86
04/01/2000	11:30:00	292.53	-0.89	27.08	306.87
04/01/2000	11:45:00	292.31	-0.89	26.7	302.01
04/01/2000	12:00:00	292.1	-0.89	26.34	297.34
04/01/2000	12:15:00	291.91	-0.86	25.98	292.83
04/01/2000	12:30:00	291.74	-0.81	25.65	288.5
04/01/2000	12:45:00	291.59	-0.74	25.32	284.32
04/01/2000	13:00:00	291.45	-0.66	25.02	280.3
04/01/2000	13:15:00	291.34	-0.59	24.72	276.38
04/01/2000	13:30:00	291.24	-0.5	24.45	272.56
04/01/2000	13:45:00	291.15	-0.37	24.19	268.78
04/01/2000	14:00:00	291.09	-0.24	23.95	265.06
04/01/2000	14:15:00	291.04	-0.1	23.72	261.4
04/01/2000	14:30:00	291.01	0.03	23.52	257.8
04/01/2000	14:45:00	290.99	0.16	23.33	254.06
04/01/2000	15:00:00	290.99	0.29	23.19	249.99
04/01/2000	15:15:00	290.99	0.42	23.05	245.47
04/01/2000	15:30:00	291.01	0.55	22.97	240.51
04/01/2000	15:45:00	291.04	0.66	22.84	235.05
04/01/2000	16:00:00	291.08	0.73	22.75	228.71
04/01/2000	16:15:00	291.14	0.78	22.67	221.08
04/01/2000	16:30:00	291.2	0.81	22.61	213.74
04/01/2000	16:45:00	291.27	0.84	22.56	210.33
04/01/2000	17:00:00	291.36	0.86	22.52	210.91
04/01/2000	17:15:00	291.41	0.86	22.5	213.23
04/01/2000	17:30:00	291.3	0.84	22.49	214.72
04/01/2000	17:45:00	291.43	0.81	22.5	215.2
04/01/2000	18:00:00	291.53	0.77	22.51	215.23
04/01/2000	18:15:00	291.67	0.73	22.54	215.37
04/01/2000	18:30:00	291.84	0.7	22.58	216
04/01/2000	18:45:00	292.03	0.67	22.64	217.13
04/01/2000	19:00:00	292.23	0.62	22.71	218.32
04/01/2000	19:15:00	292.43	0.56	22.78	218.63
04/01/2000	19:30:00	292.64	0.48	22.86	218.43
04/01/2000	19:45:00	292.84	0.39	22.94	218.12
04/01/2000	20:00:00	293.05	0.31	23.03	217.83
04/01/2000	20:15:00	293.25	0.22	23.12	217.84
04/01/2000	20:30:00	293.44	0.12	23.2	217.81
04/01/2000	20:45:00	293.62	0.01	23.29	217.37
04/01/2000	21:00:00	293.79	-0.1	23.37	216.5
04/01/2000	21:15:00	293.94	-0.22	23.45	215.25
04/01/2000	21:30:00	294.09	-0.32	23.52	213.83
04/01/2000	21:45:00	294.21	-0.41	23.59	212.29
04/01/2000	22:00:00	294.31	-0.48	23.65	210.6
04/01/2000	22:15:00	294.4	-0.53	23.7	208.72

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	22:30:00	294.5	-0.58	23.77	206.66
04/01/2000	22:45:00	294.5	-0.61	23.79	204.51
04/01/2000	23:00:00	294.5	-0.64	23.83	202.13
04/01/2000	23:15:00	294.5	-0.63	23.84	199.61
04/01/2000	23:30:00	294.5	-0.6	23.8	197.05
04/01/2000	23:45:00	294.4	-0.55	23.76	194.48
05/01/2000	00:00:00	294.4	-0.51	23.68	191.93
05/01/2000	00:15:00	294.3	-0.47	23.58	189.37
05/01/2000	00:30:00	294.1	-0.42	23.44	186.8
05/01/2000	00:45:00	294	-0.35	23.68	184.18
05/01/2000	01:00:00	293.9	-0.27	23.58	181.58
05/01/2000	01:15:00	293.7	-0.18	24.95	179.07
05/01/2000	01:30:00	293.5	-0.09	23.35	176.64
05/01/2000	01:45:00	293.3	-0.01	23.26	174.09
05/01/2000	02:00:00	293.1	0.09	23.04	171.25
05/01/2000	02:15:00	292.8	0.2	22.84	168.11
05/01/2000	02:30:00	292.6	0.34	22.54	164.71
05/01/2000	02:45:00	292.3	0.48	22.24	160.9
05/01/2000	03:00:00	292.1	0.61	22.01	155.83
05/01/2000	03:15:00	291.8	0.72	21.68	146.78
05/01/2000	03:30:00	291.6	0.83	21.31	129.09
05/01/2000	03:45:00	291.3	0.92	20.86	108.88
05/01/2000	04:00:00	291.1	1.01	20.38	102.15
05/01/2000	04:15:00	290.8	1.08	20.08	108.45
05/01/2000	04:30:00	290.6	1.12	19.88	120.59
05/01/2000	04:45:00	290.3	1.13	19.59	126.34
05/01/2000	05:00:00	290	1.12	19.44	125.55
05/01/2000	05:15:00	289.8	1.1	19.21	123.06
05/01/2000	05:30:00	289.5	1.08	19.29	124.37
05/01/2000	05:45:00	289.2	1.04	18.98	128.3
05/01/2000	06:00:00	288.9	1	18.66	135.34
05/01/2000	06:15:00	288.6	0.94	18.43	141.86
05/01/2000	06:30:00	288.3	0.87	18.16	145.41
05/01/2000	06:45:00	288	0.8	17.94	147.08
05/01/2000	07:00:00	287.7	0.72	17.88	147.29
05/01/2000	07:15:00	287.3	0.65	17.62	146.89
05/01/2000	07:30:00	287	0.58	17.43	146.38
05/01/2000	07:45:00	286.7	0.48	17.25	146.42
05/01/2000	08:00:00	286.3	0.36	17.06	150.47
05/01/2000	08:15:00	286	0.24	16.88	153.6
05/01/2000	08:30:00	285.7	0.1	16.71	152.77
05/01/2000	08:45:00	285.3	-0.03	16.54	150.03
05/01/2000	09:00:00	285	-0.16	16.38	147.5
05/01/2000	09:15:00	284.7	-0.28	16.23	144.98
05/01/2000	09:30:00	284.4	-0.4	16.08	142.39
05/01/2000	09:45:00	284	-0.51	15.93	139.67
05/01/2000	10:00:00	283.7	-0.61	15.86	136.79
05/01/2000	10:15:00	283.4	-0.7	15.96	134
05/01/2000	10:30:00	283.1	-0.77	16.51	131.16
05/01/2000	10:45:00	282.8	-0.83	17.59	128.21

Boundary Condition for return period of 5 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	11:00:00	282.52	-0.87	15.85	125.21
05/01/2000	11:15:00	282.24	-0.91	16.05	122.23
05/01/2000	11:30:00	281.97	-0.93	15.82	119.26
05/01/2000	11:45:00	281.72	-0.95	15.73	116.31
05/01/2000	12:00:00	281.48	-0.96	15.59	113.41
05/01/2000	12:15:00	281.27	-0.95	15.46	110.6
05/01/2000	12:30:00	281.08	-0.92	15.39	107.88
05/01/2000	12:45:00	280.91	-0.88	15.26	105.27
05/01/2000	13:00:00	280.77	-0.84	15.12	102.72
05/01/2000	13:15:00	280.64	-0.81	15.09	100.21
05/01/2000	13:30:00	280.53	-0.75	15	97.91
05/01/2000	13:45:00	280.44	-0.67	14.77	95.65
05/01/2000	14:00:00	280.36	-0.57	14.61	93.37
05/01/2000	14:15:00	280.28	-0.47	14.46	91.11
05/01/2000	14:30:00	280.21	-0.37	14.4	88.86
05/01/2000	14:45:00	280.14	-0.26	14.41	86.5
05/01/2000	15:00:00	280.06	-0.14	14.33	83.84
05/01/2000	15:15:00	279.98	0	14.21	80.56
05/01/2000	15:30:00	279.89	0.14	14.07	75.86
05/01/2000	15:45:00	279.78	0.27	13.88	67.36
05/01/2000	16:00:00	279.69	0.38	13.6	49.68
05/01/2000	16:15:00	279.61	0.47	13.31	24.54
05/01/2000	16:30:00	279.53	0.54	12.93	7.32
05/01/2000	16:45:00	279.47	0.61	12.5	4.99
05/01/2000	17:00:00	279.4	0.66	12.29	10.47
05/01/2000	17:15:00	279.33	0.69	12.28	17.16
05/01/2000	17:30:00	279.26	0.7	12.34	25.12

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	17:45:00	279.2	0.7	12.26	36.38
05/01/2000	18:00:00	279.1	0.68	12.33	50.92
05/01/2000	18:15:00	279	0.68	12.47	66.99
05/01/2000	18:30:00	278.8	0.68	12.45	75.46
05/01/2000	18:45:00	278.6	0.68	12.56	76.2
05/01/2000	19:00:00	278.4	0.66	12.68	72.69
05/01/2000	19:15:00	278.2	0.63	12.74	67.75
05/01/2000	19:30:00	278	0.59	12.76	62.94
05/01/2000	19:45:00	277.7	0.54	12.75	60.31
05/01/2000	20:00:00	277.4	0.49	12.74	61.56
05/01/2000	20:15:00	277.1	0.44	12.77	64.73
05/01/2000	20:30:00	276.9	0.36	12.83	66.93
05/01/2000	20:45:00	276.6	0.26	12.91	67.76
05/01/2000	21:00:00	276.3	0.14	12.92	67.93
05/01/2000	21:15:00	276	0.03	12.93	68.9
05/01/2000	21:30:00	275.8	-0.08	12.96	70.56
05/01/2000	21:45:00	275.5	-0.18	12.99	71.81
05/01/2000	22:00:00	275.2	-0.27	13.01	72.15
05/01/2000	22:15:00	275	-0.35	13.04	71.66
05/01/2000	22:30:00	274.8	-0.43	13.14	70.56
05/01/2000	22:45:00	274.6	-0.49	13.12	68.99
05/01/2000	23:00:00	274.4	-0.54	13.17	67.12
05/01/2000	23:15:00	274.2	-0.56	13.18	65.2
05/01/2000	23:30:00	274	-0.55	13.25	63.27
05/01/2000	23:45:00	273.9	-0.53	13.08	61.42
06/01/2000	00:00:00	273.7	-0.51	13.08	59.5

10.9. Boundary Condition for return period of 10 years

Date	Time	Bicol	Bay	Naga	Libmanan	Date	Time	Bicol	Bay	Naga	Libmanan
01/01/2000	00:00:00	0.00	0.00	0.00	0.00	01/01/2000	22:00:00	54.32	-0.76	14.37	50.57
01/01/2000	12:15:00	61.81	0.00	8.07	9.32	01/01/2000	22:15:00	54.41	-0.69	14.41	50.09
01/01/2000	12:30:00	61.83	0.20	11.49	22.09	01/01/2000	22:30:00	54.70	-0.60	14.45	49.75
01/01/2000	12:45:00	61.99	0.40	11.66	21.98	01/01/2000	22:45:00	54.85	-0.52	14.51	49.52
01/01/2000	13:00:00	60.78	0.46	11.92	22.99	01/01/2000	23:00:00	54.90	-0.43	14.57	49.34
01/01/2000	13:15:00	59.84	0.56	12.05	10.32	01/01/2000	23:15:00	54.91	-0.33	14.63	49.07
01/01/2000	13:30:00	59.06	0.68	11.70	-41.91	01/01/2000	23:30:00	54.93	-0.21	14.68	48.17
01/01/2000	13:45:00	58.43	0.76	5.97	-43.03	01/01/2000	23:45:00	54.96	-0.08	14.72	44.81
01/01/2000	14:00:00	57.88	0.82	9.45	-37.42	02/01/2000	00:00:00	54.96	0.06	14.76	37.62
01/01/2000	14:15:00	57.25	0.91	10.43	-37.56	02/01/2000	00:15:00	54.96	0.19	14.76	28.33
01/01/2000	14:30:00	55.77	0.97	9.18	-42.35	02/01/2000	00:30:00	54.91	0.31	14.63	21.13
01/01/2000	14:45:00	51.32	0.98	9.16	-38.93	02/01/2000	00:45:00	54.87	0.42	14.17	15.10
01/01/2000	15:00:00	46.81	0.99	9.77	-31.97	02/01/2000	01:00:00	54.78	0.54	13.49	8.98
01/01/2000	15:15:00	42.32	0.99	9.91	-27.19	02/01/2000	01:15:00	54.63	0.66	13.12	4.38
01/01/2000	15:30:00	38.63	0.97	9.84	-12.98	02/01/2000	01:30:00	54.32	0.78	13.28	0.94
01/01/2000	15:45:00	34.91	0.94	10.19	13.63	02/01/2000	01:45:00	53.61	0.88	13.33	-2.55
01/01/2000	16:00:00	30.87	0.90	10.80	31.67	02/01/2000	02:00:00	52.20	0.96	13.22	-6.59
01/01/2000	16:15:00	28.31	0.83	11.29	38.60	02/01/2000	02:15:00	49.86	1.01	13.05	-9.11
01/01/2000	16:30:00	26.32	0.75	11.94	46.22	02/01/2000	02:30:00	46.44	1.07	13.07	-7.05
01/01/2000	16:45:00	25.08	0.66	12.53	54.14	02/01/2000	02:45:00	42.38	1.11	13.33	1.12
01/01/2000	17:00:00	25.45	0.57	13.35	66.08	02/01/2000	03:00:00	38.21	1.14	13.74	16.33
01/01/2000	17:15:00	27.86	0.49	14.47	70.59	02/01/2000	03:15:00	33.77	1.14	14.05	33.54
01/01/2000	17:30:00	32.02	0.41	14.59	70.90	02/01/2000	03:30:00	29.50	1.11	14.20	47.42
01/01/2000	17:45:00	37.65	0.32	14.52	69.33	02/01/2000	03:45:00	26.14	1.06	14.69	52.16
01/01/2000	18:00:00	42.79	0.22	14.31	67.53	02/01/2000	04:00:00	23.78	1.00	15.33	52.62
01/01/2000	18:15:00	46.90	0.12	13.94	65.11	02/01/2000	04:15:00	22.12	0.93	15.69	55.90
01/01/2000	18:30:00	49.47	0.02	14.04	63.15	02/01/2000	04:30:00	21.86	0.86	16.00	64.38
01/01/2000	18:45:00	51.06	-0.07	14.09	61.95	02/01/2000	04:45:00	23.16	0.76	16.47	78.18
01/01/2000	19:00:00	51.99	-0.16	14.12	61.36	02/01/2000	05:00:00	26.18	0.66	16.95	90.38
01/01/2000	19:15:00	52.50	-0.24	14.15	60.61	02/01/2000	05:15:00	29.51	0.55	17.83	96.22
01/01/2000	19:30:00	52.77	-0.33	14.18	59.64	02/01/2000	05:30:00	32.74	0.43	18.84	104.32
01/01/2000	19:45:00	52.99	-0.42	14.18	58.44	02/01/2000	05:45:00	36.98	0.31	19.40	110.60
01/01/2000	20:00:00	53.20	-0.51	14.19	57.13	02/01/2000	06:00:00	42.31	0.21	18.84	110.89
01/01/2000	20:15:00	53.39	-0.59	14.18	55.95	02/01/2000	06:15:00	48.24	0.11	18.92	109.46
01/01/2000	20:30:00	53.56	-0.66	14.19	54.90	02/01/2000	06:30:00	53.18	0.00	18.60	107.63
01/01/2000	20:45:00	53.75	-0.71	14.22	54.02	02/01/2000	06:45:00	56.52	-0.11	18.56	105.41
01/01/2000	21:00:00	53.93	-0.75	14.25	53.21	02/01/2000	07:00:00	58.42	-0.23	18.55	102.98
01/01/2000	21:15:00	54.04	-0.78	14.27	52.49	02/01/2000	07:15:00	59.84	-0.35	18.46	100.58
01/01/2000	21:30:00	54.15	-0.80	14.30	51.80	02/01/2000	07:30:00	61.32	-0.45	18.35	98.48
01/01/2000	21:45:00	54.25	-0.80	14.34	51.15	02/01/2000	07:45:00	62.39	-0.55	18.29	96.76

Boundary Condition for return period of 10 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
02/01/2000	08:00:00	63.27	-0.64	18.21	95.21
02/01/2000	08:15:00	63.92	-0.72	18.12	93.84
02/01/2000	08:30:00	64.37	-0.80	18.04	92.51
02/01/2000	08:45:00	64.82	-0.87	17.95	91.25
02/01/2000	09:00:00	65.17	-0.94	17.86	90.16
02/01/2000	09:15:00	65.47	-0.99	17.78	89.24
02/01/2000	09:30:00	65.78	-1.03	17.70	88.50
02/01/2000	09:45:00	66.20	-1.06	17.64	87.94
02/01/2000	10:00:00	66.78	-1.08	17.60	87.56
02/01/2000	10:15:00	67.64	-1.09	17.56	87.38
02/01/2000	10:30:00	68.08	-1.07	17.54	87.42
02/01/2000	10:45:00	68.49	-1.01	17.54	87.65
02/01/2000	11:00:00	68.72	-0.91	17.54	88.07
02/01/2000	11:15:00	68.88	-0.81	17.57	88.66
02/01/2000	11:30:00	69.08	-0.71	17.59	89.44
02/01/2000	11:45:00	69.33	-0.60	17.64	90.35
02/01/2000	12:00:00	69.55	-0.49	17.72	91.37
02/01/2000	12:15:00	69.81	-0.37	17.83	92.43
02/01/2000	12:30:00	70.11	-0.23	17.98	93.40
02/01/2000	12:45:00	70.47	-0.08	18.18	93.77
02/01/2000	13:00:00	70.90	0.06	18.43	92.75
02/01/2000	13:15:00	71.44	0.19	18.71	89.80
02/01/2000	13:30:00	72.05	0.31	18.97	88.02
02/01/2000	13:45:00	72.81	0.44	19.08	88.43
02/01/2000	14:00:00	73.67	0.57	19.17	90.49
02/01/2000	14:15:00	74.65	0.70	19.67	93.92
02/01/2000	14:30:00	75.65	0.80	20.48	99.96
02/01/2000	14:45:00	76.60	0.87	21.45	107.99
02/01/2000	15:00:00	77.23	0.93	22.47	120.26
02/01/2000	15:15:00	77.51	0.97	23.99	139.52
02/01/2000	15:30:00	77.27	1.01	25.96	166.47
02/01/2000	15:45:00	76.86	1.03	28.14	198.99
02/01/2000	16:00:00	76.59	1.02	30.74	234.52
02/01/2000	16:15:00	77.39	0.99	33.65	272.56
02/01/2000	16:30:00	79.38	0.94	36.61	313.23
02/01/2000	16:45:00	83.99	0.88	39.90	352.59
02/01/2000	17:00:00	90.07	0.82	43.08	395.76
02/01/2000	17:15:00	98.87	0.77	46.82	441.33
02/01/2000	17:30:00	108.84	0.70	50.98	484.95
02/01/2000	17:45:00	119.38	0.62	55.60	529.96
02/01/2000	18:00:00	130.80	0.53	60.50	574.54
02/01/2000	18:15:00	143.40	0.43	65.12	618.27
02/01/2000	18:30:00	154.03	0.35	69.72	666.55
02/01/2000	18:45:00	160.91	0.27	74.79	711.56
02/01/2000	19:00:00	169.65	0.18	80.16	752.98
02/01/2000	19:15:00	180.08	0.09	85.80	793.60
02/01/2000	19:30:00	189.79	-0.01	91.58	835.22
02/01/2000	19:45:00	199.38	-0.12	97.51	877.45
02/01/2000	20:00:00	204.78	-0.22	103.47	919.86
02/01/2000	20:15:00	206.89	-0.31	109.44	960.54
02/01/2000	20:30:00	215.16	-0.38	115.52	998.27
02/01/2000	20:45:00	223.94	-0.45	121.61	1034.33
02/01/2000	21:00:00	233.06	-0.51	127.70	1069.91
02/01/2000	21:15:00	243.71	-0.56	133.76	1102.04
02/01/2000	21:30:00	258.30	-0.60	139.72	1131.51
02/01/2000	21:45:00	273.50	-0.63	145.52	1158.71
02/01/2000	22:00:00	286.71	-0.65	151.24	1184.12
02/01/2000	22:15:00	297.07	-0.64	156.73	1208.44
02/01/2000	22:30:00	305.56	-0.62	162.07	1231.11
02/01/2000	22:45:00	313.19	-0.59	167.12	1251.51
02/01/2000	23:00:00	320.59	-0.54	172.02	1269.78
02/01/2000	23:15:00	327.90	-0.48	176.55	1286.26
02/01/2000	23:30:00	335.02	-0.39	180.84	1301.66
02/01/2000	23:45:00	342.20	-0.29	184.67	1316.27
03/01/2000	00:00:00	349.65	-0.17	188.24	1330.69
03/01/2000	00:15:00	358.55	-0.07	191.35	1344.37
03/01/2000	00:30:00	368.09	0.03	194.19	1357.31
03/01/2000	00:45:00	375.90	0.14	196.57	1369.63
03/01/2000	01:00:00	381.16	0.27	198.66	1381.26
03/01/2000	01:15:00	385.73	0.41	200.30	1392.41
03/01/2000	01:30:00	388.26	0.54	201.70	1402.96
03/01/2000	01:45:00	389.72	0.66	202.67	1412.93
03/01/2000	02:00:00	390.10	0.77	203.37	1422.02
03/01/2000	02:15:00	394.70	0.87	203.67	1430.73
03/01/2000	02:30:00	399.62	0.97	203.66	1438.71
03/01/2000	02:45:00	402.41	1.06	203.29	1446.10
03/01/2000	03:00:00	403.43	1.14	203.06	1452.49
03/01/2000	03:15:00	402.93	1.18	202.14	1458.30
03/01/2000	03:30:00	401.30	1.21	201.15	1462.99
03/01/2000	03:45:00	398.80	1.21	199.75	1466.81
03/01/2000	04:00:00	395.63	1.19	198.16	1469.68
03/01/2000	04:15:00	392.00	1.17	196.21	1471.97
03/01/2000	04:30:00	388.21	1.13	194.02	1473.13
03/01/2000	04:45:00	384.42	1.22	191.56	1473.75
03/01/2000	05:00:00	380.64	1.27	188.88	1473.59
03/01/2000	05:15:00	376.92	1.44	185.97	1472.92
03/01/2000	05:30:00	373.28	1.55	182.91	1471.29
03/01/2000	05:45:00	369.70	1.69	179.69	1469.12
03/01/2000	06:00:00	366.21	1.89	176.36	1465.98
03/01/2000	06:15:00	362.80	1.98	172.89	1462.32
03/01/2000	06:30:00	359.48	2.04	169.31	1457.80
03/01/2000	06:45:00	356.21	2.13	165.64	1452.84
03/01/2000	07:00:00	352.98	2.15	161.91	1447.10
03/01/2000	07:15:00	349.75	2.14	158.11	1440.73
03/01/2000	07:30:00	346.53	2.12	154.22	1433.49
03/01/2000	07:45:00	343.24	2.06	150.31	1426.04
03/01/2000	08:00:00	339.90	1.96	146.39	1417.95
03/01/2000	08:15:00	336.55	1.86	142.48	1409.44
03/01/2000	08:30:00	333.21	1.71	138.54	1400.35
03/01/2000	08:45:00	329.88	1.54	135.14	1391.25

Boundary Condition for return period of 10 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
03/01/2000	09:00:00	326.58	1.36	130.86	1381.75
03/01/2000	09:15:00	323.29	1.19	126.72	1372.17
03/01/2000	09:30:00	320.05	1.02	123.57	1362.14
03/01/2000	09:45:00	316.82	0.86	120.12	1351.91
03/01/2000	10:00:00	314.47	0.72	116.80	1341.00
03/01/2000	10:15:00	314.17	0.59	113.56	1329.67
03/01/2000	10:30:00	313.50	0.48	110.49	1317.49
03/01/2000	10:45:00	312.46	0.38	107.58	1304.77
03/01/2000	11:00:00	311.25	0.31	104.69	1291.29
03/01/2000	11:15:00	309.95	0.25	101.94	1277.51
03/01/2000	11:30:00	308.53	0.21	99.29	1263.10
03/01/2000	11:45:00	307.23	0.18	96.72	1248.30
03/01/2000	12:00:00	307.07	0.15	94.21	1232.85
03/01/2000	12:15:00	305.99	0.14	91.80	1217.32
03/01/2000	12:30:00	304.24	0.13	89.46	1201.86
03/01/2000	12:45:00	303.01	0.13	87.22	1185.53
03/01/2000	13:00:00	302.60	0.12	84.97	1168.59
03/01/2000	13:15:00	300.98	0.11	82.86	1151.33
03/01/2000	13:30:00	304.26	0.00	80.86	1132.89
03/01/2000	13:45:00	303.95	-0.06	78.90	1114.10
03/01/2000	14:00:00	302.62	0.40	76.93	1095.74
03/01/2000	14:15:00	301.59	0.34	75.09	1078.08
03/01/2000	14:30:00	300.53	0.45	73.33	1061.31
03/01/2000	14:45:00	299.49	0.62	71.65	1043.93
03/01/2000	15:00:00	298.47	0.74	70.00	1025.14
03/01/2000	15:15:00	297.48	0.76	68.19	1007.17
03/01/2000	15:30:00	296.50	0.87	66.82	988.85
03/01/2000	15:45:00	295.56	0.97	65.30	970.27
03/01/2000	16:00:00	294.62	0.97	63.86	951.80
03/01/2000	16:15:00	293.76	0.97	62.53	933.94
03/01/2000	16:30:00	292.92	0.99	61.42	916.15
03/01/2000	16:45:00	292.10	0.96	60.16	898.85
03/01/2000	17:00:00	291.30	0.93	59.23	882.03
03/01/2000	17:15:00	290.52	0.91	58.25	865.59
03/01/2000	17:30:00	289.75	0.88	57.26	849.57
03/01/2000	17:45:00	288.99	0.81	56.40	833.76
03/01/2000	18:00:00	288.27	0.75	55.59	818.51
03/01/2000	18:15:00	287.62	0.69	54.80	803.51
03/01/2000	18:30:00	287.01	0.62	54.05	788.89
03/01/2000	18:45:00	286.47	0.55	53.35	774.55
03/01/2000	19:00:00	286.00	0.49	52.68	760.64
03/01/2000	19:15:00	285.59	0.40	52.04	748.22
03/01/2000	19:30:00	285.25	0.30	51.47	736.90
03/01/2000	19:45:00	284.97	0.20	50.90	725.45
03/01/2000	20:00:00	284.77	0.10	50.30	714.07
03/01/2000	20:15:00	284.63	0.01	49.75	702.98
03/01/2000	20:30:00	284.57	-0.08	49.27	692.02
03/01/2000	20:45:00	284.58	-0.17	48.78	681.19
03/01/2000	21:00:00	284.65	-0.25	48.27	670.66
03/01/2000	21:15:00	284.77	-0.33	47.80	660.31
03/01/2000	21:30:00	284.93	-0.40	47.38	650.27
03/01/2000	21:45:00	285.12	-0.46	47.01	640.43
03/01/2000	22:00:00	285.35	-0.50	46.45	630.80
03/01/2000	22:15:00	285.63	-0.52	46.44	621.91
03/01/2000	22:30:00	285.98	-0.53	46.04	613.42
03/01/2000	22:45:00	286.53	-0.54	45.92	604.63
03/01/2000	23:00:00	287.15	-0.54	46.22	596.00
03/01/2000	23:15:00	287.76	-0.52	44.30	587.83
03/01/2000	23:30:00	288.42	-0.48	44.20	581.80
03/01/2000	23:45:00	289.17	-0.42	44.02	573.05
04/01/2000	00:00:00	290.13	-0.35	43.62	564.71
04/01/2000	00:15:00	290.98	-0.29	43.38	557.00
04/01/2000	00:30:00	291.71	-0.22	43.06	549.78
04/01/2000	00:45:00	292.44	-0.14	42.74	542.67
04/01/2000	01:00:00	293.17	-0.03	42.44	535.62
04/01/2000	01:15:00	293.90	0.09	42.14	528.59
04/01/2000	01:30:00	294.64	0.21	41.88	521.67
04/01/2000	01:45:00	295.39	0.32	41.58	514.61
04/01/2000	02:00:00	296.14	0.43	41.24	507.27
04/01/2000	02:15:00	296.87	0.56	40.86	499.43
04/01/2000	02:30:00	297.59	0.70	40.41	491.07
04/01/2000	02:45:00	298.28	0.83	39.86	482.78
04/01/2000	03:00:00	298.93	0.94	39.30	473.85
04/01/2000	03:15:00	299.52	1.03	38.88	463.85
04/01/2000	03:30:00	300.02	1.10	38.41	455.21
04/01/2000	03:45:00	300.38	1.15	38.05	449.26
04/01/2000	04:00:00	300.70	1.18	37.79	444.16
04/01/2000	04:15:00	300.96	1.21	38.53	437.79
04/01/2000	04:30:00	301.10	1.22	37.99	430.74
04/01/2000	04:45:00	301.28	1.19	37.36	425.16
04/01/2000	05:00:00	301.55	1.14	37.13	419.64
04/01/2000	05:15:00	301.72	1.07	36.74	413.92
04/01/2000	05:30:00	301.88	1.00	36.34	408.09
04/01/2000	05:45:00	301.99	0.94	36.02	403.06
04/01/2000	06:00:00	302.06	0.87	35.59	399.37
04/01/2000	06:15:00	302.11	0.79	35.22	396.24
04/01/2000	06:30:00	302.15	0.70	34.96	392.44
04/01/2000	06:45:00	302.19	0.59	34.63	388.01
04/01/2000	07:00:00	302.22	0.49	34.29	382.90
04/01/2000	07:15:00	302.25	0.39	33.89	377.68
04/01/2000	07:30:00	302.30	0.28	33.49	373.37
04/01/2000	07:45:00	302.36	0.17	32.96	371.13
04/01/2000	08:00:00	302.42	0.05	32.57	368.46
04/01/2000	08:15:00	302.45	-0.08	32.32	365.19
04/01/2000	08:30:00	302.47	-0.21	31.76	358.77
04/01/2000	08:45:00	302.47	-0.33	29.86	352.83
04/01/2000	09:00:00	302.47	-0.43	31.11	347.36
04/01/2000	09:15:00	302.47	-0.52	30.36	342.38
04/01/2000	09:30:00	302.46	-0.60	30.39	337.42
04/01/2000	09:45:00	302.44	-0.67	29.79	332.29

Boundary Condition for return period of 10 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	10:00:00	302.53	-0.72	29.11	327.14
04/01/2000	10:15:00	302.67	-0.77	28.68	321.90
04/01/2000	10:30:00	302.69	-0.81	28.21	316.58
04/01/2000	10:45:00	302.72	-0.84	27.74	311.44
04/01/2000	11:00:00	302.63	-0.86	27.32	306.79
04/01/2000	11:15:00	302.52	-0.87	26.92	302.30
04/01/2000	11:30:00	302.40	-0.88	26.50	297.76
04/01/2000	11:45:00	302.30	-0.88	26.12	293.29
04/01/2000	12:00:00	302.23	-0.87	25.76	288.87
04/01/2000	12:15:00	302.17	-0.83	25.42	284.52
04/01/2000	12:30:00	302.12	-0.78	25.09	280.56
04/01/2000	12:45:00	302.08	-0.72	24.78	276.80
04/01/2000	13:00:00	302.04	-0.65	24.49	273.00
04/01/2000	13:15:00	302.01	-0.58	24.19	269.28
04/01/2000	13:30:00	301.97	-0.50	23.93	265.71
04/01/2000	13:45:00	301.94	-0.38	23.67	262.01
04/01/2000	14:00:00	301.92	-0.24	23.42	258.32
04/01/2000	14:15:00	301.90	-0.10	23.19	254.66
04/01/2000	14:30:00	301.89	0.03	22.97	250.93
04/01/2000	14:45:00	301.90	0.16	22.75	246.75
04/01/2000	15:00:00	301.92	0.29	22.53	241.17
04/01/2000	15:15:00	301.89	0.42	22.21	234.26
04/01/2000	15:30:00	301.83	0.55	21.80	227.08
04/01/2000	15:45:00	301.80	0.66	21.32	219.45
04/01/2000	16:00:00	301.78	0.73	21.00	211.02
04/01/2000	16:15:00	301.75	0.78	20.74	202.79
04/01/2000	16:30:00	301.69	0.81	20.68	196.88
04/01/2000	16:45:00	301.57	0.84	20.78	195.70
04/01/2000	17:00:00	301.36	0.86	21.13	199.18
04/01/2000	17:15:00	301.06	0.86	21.23	204.14
04/01/2000	17:30:00	300.51	0.85	21.48	207.30
04/01/2000	17:45:00	300.15	0.81	21.57	208.16
04/01/2000	18:00:00	299.89	0.77	21.67	208.76
04/01/2000	18:15:00	299.62	0.73	21.88	209.87
04/01/2000	18:30:00	299.40	0.70	22.20	211.96
04/01/2000	18:45:00	299.25	0.67	22.46	213.04
04/01/2000	19:00:00	299.21	0.62	22.52	213.29
04/01/2000	19:15:00	299.30	0.56	22.55	212.32
04/01/2000	19:30:00	299.49	0.48	22.56	210.89
04/01/2000	19:45:00	299.70	0.40	22.51	209.64
04/01/2000	20:00:00	299.89	0.31	22.54	208.84
04/01/2000	20:15:00	300.05	0.22	22.64	208.48
04/01/2000	20:30:00	300.19	0.12	22.73	208.13
04/01/2000	20:45:00	300.39	0.01	22.81	207.47
04/01/2000	21:00:00	300.58	-0.10	22.87	206.40
04/01/2000	21:15:00	300.70	-0.21	22.92	205.16
04/01/2000	21:30:00	300.81	-0.32	22.96	203.90
04/01/2000	21:45:00	300.88	-0.40	23.01	202.66
04/01/2000	22:00:00	300.93	-0.47	23.01	201.08
04/01/2000	22:15:00	300.98	-0.53	23.01	199.18

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	22:30:00	301.03	-0.57	23.02	197.03
04/01/2000	22:45:00	301.07	-0.61	23.00	194.76
04/01/2000	23:00:00	301.19	-0.63	22.99	192.08
04/01/2000	23:15:00	301.43	-0.63	22.94	189.24
04/01/2000	23:30:00	302.12	-0.59	22.87	186.41
04/01/2000	23:45:00	302.20	-0.54	22.83	183.62
05/01/2000	00:00:00	302.10	-0.50	22.74	180.87
05/01/2000	00:15:00	301.94	-0.46	22.63	178.17
05/01/2000	00:30:00	301.69	-0.42	22.47	175.46
05/01/2000	00:45:00	301.38	-0.35	22.43	172.66
05/01/2000	01:00:00	301.05	-0.27	22.28	169.83
05/01/2000	01:15:00	300.70	-0.18	22.61	167.07
05/01/2000	01:30:00	300.37	-0.09	21.93	164.28
05/01/2000	01:45:00	300.02	-0.01	21.77	160.83
05/01/2000	02:00:00	299.64	0.09	21.54	155.27
05/01/2000	02:15:00	299.23	0.20	21.26	148.96
05/01/2000	02:30:00	298.80	0.33	20.89	143.21
05/01/2000	02:45:00	298.34	0.47	20.45	138.65
05/01/2000	03:00:00	297.87	0.61	20.04	133.47
05/01/2000	03:15:00	297.37	0.72	19.56	125.68
05/01/2000	03:30:00	296.84	0.83	19.05	114.34
05/01/2000	03:45:00	296.26	0.92	18.56	102.81
05/01/2000	04:00:00	295.61	1.01	18.13	96.82
05/01/2000	04:15:00	294.86	1.08	18.08	97.35
05/01/2000	04:30:00	293.92	1.12	18.04	102.25
05/01/2000	04:45:00	292.76	1.13	18.05	105.42
05/01/2000	05:00:00	291.31	1.12	17.89	108.94
05/01/2000	05:15:00	289.70	1.10	17.57	113.59
05/01/2000	05:30:00	288.25	1.07	17.75	116.50
05/01/2000	05:45:00	286.94	1.04	17.93	118.39
05/01/2000	06:00:00	285.75	1.00	17.80	123.56
05/01/2000	06:15:00	284.81	0.95	17.57	129.12
05/01/2000	06:30:00	284.20	0.88	17.43	133.10
05/01/2000	06:45:00	284.33	0.80	17.28	135.61
05/01/2000	07:00:00	284.46	0.72	17.39	136.62
05/01/2000	07:15:00	284.49	0.65	17.36	137.41
05/01/2000	07:30:00	284.76	0.58	17.51	140.61
05/01/2000	07:45:00	284.90	0.48	17.56	142.62
05/01/2000	08:00:00	285.10	0.37	17.37	142.13
05/01/2000	08:15:00	285.40	0.24	17.07	142.03
05/01/2000	08:30:00	285.57	0.10	16.81	140.28
05/01/2000	08:45:00	285.74	-0.03	16.69	138.89
05/01/2000	09:00:00	285.89	-0.15	16.51	138.43
05/01/2000	09:15:00	285.89	-0.28	16.34	137.40
05/01/2000	09:30:00	285.76	-0.40	16.19	135.46
05/01/2000	09:45:00	285.65	-0.51	16.02	132.75
05/01/2000	10:00:00	285.54	-0.61	15.91	129.71
05/01/2000	10:15:00	285.45	-0.70	15.82	126.61
05/01/2000	10:30:00	285.37	-0.77	15.91	123.46
05/01/2000	10:45:00	285.39	-0.83	16.18	120.33

Boundary Condition for return period of 10 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	11:00:00	285.57	-0.87	15.51	117.19
05/01/2000	11:15:00	285.85	-0.90	15.50	114.08
05/01/2000	11:30:00	285.78	-0.93	15.35	111.06
05/01/2000	11:45:00	285.54	-0.94	15.23	108.14
05/01/2000	12:00:00	285.26	-0.95	15.10	105.30
05/01/2000	12:15:00	284.96	-0.94	14.96	102.56
05/01/2000	12:30:00	284.60	-0.90	14.85	99.91
05/01/2000	12:45:00	284.21	-0.87	14.72	97.38
05/01/2000	13:00:00	283.85	-0.83	14.59	94.97
05/01/2000	13:15:00	283.51	-0.80	14.51	92.59
05/01/2000	13:30:00	283.17	-0.75	14.40	90.33
05/01/2000	13:45:00	282.85	-0.67	14.26	88.11
05/01/2000	14:00:00	282.54	-0.57	14.14	85.92
05/01/2000	14:15:00	282.24	-0.48	14.03	83.78
05/01/2000	14:30:00	281.90	-0.38	13.94	81.65
05/01/2000	14:45:00	281.51	-0.27	13.89	79.26
05/01/2000	15:00:00	281.10	-0.14	13.80	75.76
05/01/2000	15:15:00	280.69	0.00	13.68	70.61
05/01/2000	15:30:00	280.29	0.14	13.55	63.28
05/01/2000	15:45:00	279.86	0.27	13.35	55.08
05/01/2000	16:00:00	279.44	0.38	13.03	44.90
05/01/2000	16:15:00	279.02	0.46	12.59	30.40
05/01/2000	16:30:00	278.57	0.54	12.07	15.35
05/01/2000	16:45:00	278.11	0.61	11.73	8.49
05/01/2000	17:00:00	277.60	0.66	11.68	9.96
05/01/2000	17:15:00	277.02	0.69	11.73	13.21
05/01/2000	17:30:00	276.31	0.70	11.81	17.34

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	17:45:00	275.45	0.69	11.79	23.56
05/01/2000	18:00:00	274.46	0.68	11.88	32.76
05/01/2000	18:15:00	273.38	0.68	12.05	45.10
05/01/2000	18:30:00	272.30	0.68	12.27	57.38
05/01/2000	18:45:00	271.20	0.68	12.60	65.93
05/01/2000	19:00:00	270.21	0.66	12.84	67.57
05/01/2000	19:15:00	269.58	0.63	12.81	64.65
05/01/2000	19:30:00	269.36	0.59	12.81	61.05
05/01/2000	19:45:00	269.34	0.54	12.86	59.31
05/01/2000	20:00:00	269.41	0.49	12.97	61.06
05/01/2000	20:15:00	269.44	0.44	13.07	63.98
05/01/2000	20:30:00	269.39	0.36	13.07	65.49
05/01/2000	20:45:00	269.33	0.26	13.05	65.66
05/01/2000	21:00:00	269.29	0.14	13.03	65.44
05/01/2000	21:15:00	269.24	0.03	13.02	66.31
05/01/2000	21:30:00	269.13	-0.08	13.05	67.88
05/01/2000	21:45:00	269.00	-0.17	13.10	69.15
05/01/2000	22:00:00	268.85	-0.26	13.11	69.55
05/01/2000	22:15:00	268.68	-0.35	13.12	69.08
05/01/2000	22:30:00	268.52	-0.43	13.15	67.94
05/01/2000	22:45:00	268.36	-0.49	13.10	66.38
05/01/2000	23:00:00	268.19	-0.53	13.10	64.65
05/01/2000	23:15:00	268.02	-0.56	13.07	62.81
05/01/2000	23:30:00	267.85	-0.55	13.06	60.98
05/01/2000	23:45:00	267.68	-0.52	12.97	59.18
06/01/2000	00:00:00	267.50	-0.51	12.93	57.31

10.10. Boundary Condition for return period of 25 years

Date	Time	Bicol	Bay	Naga	Libmanan
01/01/2000	00:00:00	0.00	0.00	0.00	0.00
01/01/2000	12:15:00	61.90	0.00	8.97	9.34
01/01/2000	12:30:00	61.97	0.20	11.58	22.29
01/01/2000	12:45:00	62.16	0.40	11.80	22.25
01/01/2000	13:00:00	60.99	0.46	11.98	23.26
01/01/2000	13:15:00	60.09	0.56	12.09	10.78
01/01/2000	13:30:00	59.36	0.68	11.97	-41.50
01/01/2000	13:45:00	58.79	0.76	8.61	-42.41
01/01/2000	14:00:00	58.29	0.83	10.14	-36.13
01/01/2000	14:15:00	57.73	0.91	11.10	-36.62
01/01/2000	14:30:00	56.33	0.97	10.18	-41.04
01/01/2000	14:45:00	51.95	0.98	10.11	-37.22
01/01/2000	15:00:00	47.52	0.99	10.58	-29.76
01/01/2000	15:15:00	43.15	0.99	10.78	-24.63
01/01/2000	15:30:00	39.60	0.97	10.68	-9.37
01/01/2000	15:45:00	35.98	0.94	10.99	17.79
01/01/2000	16:00:00	32.16	0.90	11.49	35.70
01/01/2000	16:15:00	29.84	0.84	11.90	42.31
01/01/2000	16:30:00	27.97	0.75	12.46	49.60
01/01/2000	16:45:00	26.88	0.66	12.94	57.51
01/01/2000	17:00:00	27.62	0.57	13.60	69.44
01/01/2000	17:15:00	30.30	0.49	14.43	74.99
01/01/2000	17:30:00	34.74	0.41	14.58	75.72
01/01/2000	17:45:00	40.28	0.32	14.57	74.83
01/01/2000	18:00:00	45.11	0.22	14.71	73.52
01/01/2000	18:15:00	49.35	0.12	14.38	71.79
01/01/2000	18:30:00	52.19	0.02	14.53	70.35
01/01/2000	18:45:00	53.94	-0.07	14.69	69.86
01/01/2000	19:00:00	55.10	-0.15	14.80	69.83
01/01/2000	19:15:00	55.96	-0.24	14.91	69.75
01/01/2000	19:30:00	56.58	-0.33	15.04	69.44
01/01/2000	19:45:00	56.96	-0.42	15.16	68.94
01/01/2000	20:00:00	57.37	-0.51	15.27	68.34
01/01/2000	20:15:00	57.80	-0.59	15.40	67.91
01/01/2000	20:30:00	58.19	-0.65	15.53	67.63
01/01/2000	20:45:00	58.58	-0.70	15.68	67.54
01/01/2000	21:00:00	58.98	-0.75	15.83	67.56
01/01/2000	21:15:00	59.40	-0.78	16.00	67.67
01/01/2000	21:30:00	59.83	-0.80	16.18	67.86
01/01/2000	21:45:00	60.26	-0.80	16.35	68.18

Date	Time	Bicol	Bay	Naga	Libmanan
01/01/2000	22:00:00	60.55	-0.76	16.53	68.66
01/01/2000	22:15:00	60.88	-0.68	16.72	69.28
01/01/2000	22:30:00	61.29	-0.60	16.92	70.06
01/01/2000	22:45:00	61.83	-0.51	17.13	70.99
01/01/2000	23:00:00	62.36	-0.43	17.36	72.06
01/01/2000	23:15:00	62.80	-0.32	17.59	73.14
01/01/2000	23:30:00	63.25	-0.21	17.82	74.02
01/01/2000	23:45:00	63.67	-0.08	18.04	74.35
02/01/2000	00:00:00	64.00	0.06	18.27	73.24
02/01/2000	00:15:00	64.36	0.19	18.48	69.24
02/01/2000	00:30:00	64.73	0.31	18.65	63.55
02/01/2000	00:45:00	65.12	0.42	18.70	56.49
02/01/2000	01:00:00	65.49	0.54	18.49	49.21
02/01/2000	01:15:00	65.82	0.67	18.30	44.63
02/01/2000	01:30:00	66.01	0.78	18.36	43.37
02/01/2000	01:45:00	65.87	0.88	18.61	42.49
02/01/2000	02:00:00	65.10	0.96	18.73	40.52
02/01/2000	02:15:00	63.60	1.01	18.76	40.81
02/01/2000	02:30:00	61.17	1.07	18.89	48.31
02/01/2000	02:45:00	57.62	1.11	19.48	61.52
02/01/2000	03:00:00	53.87	1.14	19.82	82.62
02/01/2000	03:15:00	49.94	1.14	19.92	93.98
02/01/2000	03:30:00	47.27	1.12	20.38	97.99
02/01/2000	03:45:00	45.58	1.06	21.02	95.33
02/01/2000	04:00:00	44.11	1.00	21.53	95.60
02/01/2000	04:15:00	44.28	0.93	21.48	100.43
02/01/2000	04:30:00	45.45	0.86	21.72	110.36
02/01/2000	04:45:00	47.22	0.76	22.60	121.88
02/01/2000	05:00:00	50.88	0.66	22.71	130.93
02/01/2000	05:15:00	54.96	0.55	22.92	135.57
02/01/2000	05:30:00	59.21	0.43	23.17	138.99
02/01/2000	05:45:00	62.01	0.31	23.54	146.33
02/01/2000	06:00:00	64.44	0.21	24.08	151.91
02/01/2000	06:15:00	66.89	0.11	24.57	152.42
02/01/2000	06:30:00	68.93	0.00	23.90	151.40
02/01/2000	06:45:00	71.74	-0.11	23.85	149.77
02/01/2000	07:00:00	73.51	-0.23	23.77	148.16
02/01/2000	07:15:00	74.64	-0.34	23.68	146.49
02/01/2000	07:30:00	75.99	-0.45	23.56	145.07
02/01/2000	07:45:00	76.95	-0.54	23.45	143.98

Boundary Condition for return period of 25 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
02/01/2000	08:00:00	77.82	-0.63	23.35	143.13
02/01/2000	08:15:00	78.60	-0.71	23.26	142.51
02/01/2000	08:30:00	79.38	-0.79	23.19	141.98
02/01/2000	08:45:00	80.15	-0.86	23.11	141.61
02/01/2000	09:00:00	80.92	-0.92	23.04	141.45
02/01/2000	09:15:00	81.67	-0.97	22.99	141.51
02/01/2000	09:30:00	82.44	-1.01	22.95	141.82
02/01/2000	09:45:00	83.55	-1.04	22.93	142.39
02/01/2000	10:00:00	85.15	-1.06	22.95	143.22
02/01/2000	10:15:00	87.62	-1.07	22.96	144.27
02/01/2000	10:30:00	88.67	-1.06	23.03	145.56
02/01/2000	10:45:00	89.31	-1.00	23.10	147.08
02/01/2000	11:00:00	89.84	-0.90	23.17	148.82
02/01/2000	11:15:00	90.33	-0.80	23.27	150.77
02/01/2000	11:30:00	90.71	-0.70	23.39	152.93
02/01/2000	11:45:00	91.07	-0.59	23.54	155.26
02/01/2000	12:00:00	91.49	-0.48	23.72	157.73
02/01/2000	12:15:00	91.99	-0.35	23.97	160.33
02/01/2000	12:30:00	92.61	-0.21	24.31	163.49
02/01/2000	12:45:00	93.43	-0.07	24.75	167.19
02/01/2000	13:00:00	94.42	0.07	25.29	171.58
02/01/2000	13:15:00	95.61	0.20	25.98	176.14
02/01/2000	13:30:00	96.91	0.32	26.83	181.01
02/01/2000	13:45:00	98.45	0.45	27.78	186.98
02/01/2000	14:00:00	100.21	0.58	28.78	195.91
02/01/2000	14:15:00	102.31	0.70	30.02	207.47
02/01/2000	14:30:00	104.65	0.80	31.75	223.59
02/01/2000	14:45:00	107.27	0.88	33.75	243.23
02/01/2000	15:00:00	109.92	0.93	35.93	270.06
02/01/2000	15:15:00	112.82	0.98	39.13	306.36
02/01/2000	15:30:00	115.86	1.02	42.35	351.47
02/01/2000	15:45:00	119.15	1.03	46.21	400.32
02/01/2000	16:00:00	123.26	1.03	51.31	453.44
02/01/2000	16:15:00	128.45	0.99	55.88	508.93
02/01/2000	16:30:00	136.56	0.94	60.35	569.83
02/01/2000	16:45:00	149.61	0.88	65.93	635.45
02/01/2000	17:00:00	163.57	0.82	71.65	715.53
02/01/2000	17:15:00	179.03	0.77	77.97	800.51
02/01/2000	17:30:00	195.41	0.70	84.94	873.76
02/01/2000	17:45:00	212.60	0.63	92.51	948.52
02/01/2000	18:00:00	230.56	0.54	100.53	1022.37
02/01/2000	18:15:00	248.89	0.44	109.25	1098.91
02/01/2000	18:30:00	257.26	0.36	118.10	1177.25
02/01/2000	18:45:00	250.66	0.28	127.46	1252.29
02/01/2000	19:00:00	253.66	0.19	137.25	1321.97
02/01/2000	19:15:00	264.02	0.11	147.39	1390.44
02/01/2000	19:30:00	273.51	0.01	157.67	1459.72
02/01/2000	19:45:00	283.69	-0.09	168.20	1533.65
02/01/2000	20:00:00	294.93	-0.18	178.86	1607.29
02/01/2000	20:15:00	307.03	-0.27	189.57	1674.81

Date	Time	Bicol	Bay	Naga	Libmanan
02/01/2000	20:30:00	320.74	-0.33	200.33	1736.54
02/01/2000	20:45:00	336.62	-0.39	211.06	1794.47
02/01/2000	21:00:00	354.05	-0.44	221.78	1853.62
02/01/2000	21:15:00	375.84	-0.49	232.44	1904.61
02/01/2000	21:30:00	409.69	-0.52	242.87	1951.92
02/01/2000	21:45:00	446.12	-0.54	252.97	1995.36
02/01/2000	22:00:00	476.16	-0.55	262.89	2034.91
02/01/2000	22:15:00	497.03	-0.55	272.33	2070.16
02/01/2000	22:30:00	511.43	-0.53	281.55	2102.99
02/01/2000	22:45:00	522.68	-0.51	290.19	2132.89
02/01/2000	23:00:00	533.22	-0.47	298.56	2160.17
02/01/2000	23:15:00	543.11	-0.42	306.21	2184.48
02/01/2000	23:30:00	552.65	-0.35	313.49	2206.75
02/01/2000	23:45:00	561.68	-0.26	319.87	2227.44
03/01/2000	00:00:00	570.29	-0.15	325.83	2248.16
03/01/2000	00:15:00	580.10	-0.05	330.91	2267.22
03/01/2000	00:30:00	591.17	0.05	335.60	2284.89
03/01/2000	00:45:00	596.81	0.15	339.36	2301.43
03/01/2000	01:00:00	599.08	0.28	342.71	2316.89
03/01/2000	01:15:00	604.11	0.42	345.22	2331.63
03/01/2000	01:30:00	606.42	0.55	347.36	2345.43
03/01/2000	01:45:00	607.47	0.66	348.67	2358.36
03/01/2000	02:00:00	606.19	0.77	349.63	2370.33
03/01/2000	02:15:00	619.17	0.87	349.83	2381.67
03/01/2000	02:30:00	633.63	0.97	349.71	2391.68
03/01/2000	02:45:00	641.73	1.07	348.85	2400.71
03/01/2000	03:00:00	644.79	1.14	347.65	2408.08
03/01/2000	03:15:00	643.57	1.19	345.77	2414.35
03/01/2000	03:30:00	638.99	1.21	343.59	2418.85
03/01/2000	03:45:00	632.06	1.21	340.73	2422.34
03/01/2000	04:00:00	623.67	1.20	337.57	2424.21
03/01/2000	04:15:00	614.66	1.17	333.76	2425.14
03/01/2000	04:30:00	605.59	1.15	329.65	2424.51
03/01/2000	04:45:00	596.85	1.57	324.96	2422.98
03/01/2000	05:00:00	588.49	1.86	320.00	2419.95
03/01/2000	05:15:00	580.63	2.05	314.54	2416.07
03/01/2000	05:30:00	573.36	2.34	308.86	2410.79
03/01/2000	05:45:00	566.63	2.54	302.88	2404.71
03/01/2000	06:00:00	560.33	2.73	296.79	2397.22
03/01/2000	06:15:00	554.37	2.92	290.44	2389.01
03/01/2000	06:30:00	548.66	3.04	283.98	2379.56
03/01/2000	06:45:00	543.06	3.13	277.37	2369.44
03/01/2000	07:00:00	537.51	3.18	270.68	2358.19
03/01/2000	07:15:00	531.93	3.18	263.88	2346.34
03/01/2000	07:30:00	526.30	3.15	257.03	2333.30
03/01/2000	07:45:00	520.61	3.07	250.15	2319.68
03/01/2000	08:00:00	514.88	2.96	243.25	2305.11
03/01/2000	08:15:00	509.14	2.82	236.36	2289.90
03/01/2000	08:30:00	503.38	2.62	229.46	2273.53
03/01/2000	08:45:00	497.56	2.38	224.17	2257.16

Boundary Condition for return period of 25 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
03/01/2000	09:00:00	491.71	2.12	215.94	2240.42
03/01/2000	09:15:00	485.79	1.86	208.05	2223.79
03/01/2000	09:30:00	479.84	1.63	203.17	2206.64
03/01/2000	09:45:00	473.80	1.40	197.16	2189.26
03/01/2000	10:00:00	470.39	1.19	191.40	2170.78
03/01/2000	10:15:00	473.32	1.00	185.71	2151.42
03/01/2000	10:30:00	474.90	0.83	180.37	2130.74
03/01/2000	10:45:00	475.08	0.69	175.36	2109.24
03/01/2000	11:00:00	474.63	0.58	170.30	2086.58
03/01/2000	11:15:00	473.95	0.50	165.46	2063.43
03/01/2000	11:30:00	472.84	0.44	160.76	2039.26
03/01/2000	11:45:00	471.96	0.39	156.25	2014.46
03/01/2000	12:00:00	474.67	0.35	151.83	1988.78
03/01/2000	12:15:00	474.42	0.32	147.59	1962.62
03/01/2000	12:30:00	472.24	0.30	143.44	1935.87
03/01/2000	12:45:00	471.80	0.29	139.47	1908.57
03/01/2000	13:00:00	474.16	0.28	135.59	1880.72
03/01/2000	13:15:00	472.33	0.26	131.89	1852.47
03/01/2000	13:30:00	470.17	0.19	128.30	1821.28
03/01/2000	13:45:00	468.05	0.11	124.87	1789.39
03/01/2000	14:00:00	465.97	0.47	121.53	1759.29
03/01/2000	14:15:00	463.93	0.41	118.37	1731.23
03/01/2000	14:30:00	461.92	0.50	115.31	1705.47
03/01/2000	14:45:00	459.97	0.67	112.40	1677.80
03/01/2000	15:00:00	458.07	0.76	109.57	1649.33
03/01/2000	15:15:00	456.28	0.79	106.89	1620.41
03/01/2000	15:30:00	454.54	0.90	104.29	1591.32
03/01/2000	15:45:00	452.87	0.99	101.83	1561.96
03/01/2000	16:00:00	451.26	0.99	99.59	1532.57
03/01/2000	16:15:00	449.73	1.00	97.41	1503.20
03/01/2000	16:30:00	448.27	1.02	95.35	1474.07
03/01/2000	16:45:00	446.89	0.99	93.39	1446.16
03/01/2000	17:00:00	445.61	0.96	91.50	1418.81
03/01/2000	17:15:00	444.39	0.94	89.72	1391.22
03/01/2000	17:30:00	443.22	0.91	88.00	1363.64
03/01/2000	17:45:00	442.11	0.85	86.37	1336.33
03/01/2000	18:00:00	441.06	0.79	84.82	1309.85
03/01/2000	18:15:00	440.11	0.73	83.36	1283.90
03/01/2000	18:30:00	439.22	0.66	81.95	1258.75
03/01/2000	18:45:00	438.41	0.60	80.64	1234.11
03/01/2000	19:00:00	437.69	0.54	79.36	1210.22
03/01/2000	19:15:00	437.08	0.46	78.13	1186.99
03/01/2000	19:30:00	436.58	0.37	76.93	1165.26
03/01/2000	19:45:00	436.18	0.28	75.82	1144.17
03/01/2000	20:00:00	435.93	0.19	74.74	1123.73
03/01/2000	20:15:00	435.81	0.10	73.72	1103.66
03/01/2000	20:30:00	435.81	0.03	72.73	1084.53
03/01/2000	20:45:00	435.96	-0.05	71.78	1066.18
03/01/2000	21:00:00	436.29	-0.12	70.85	1048.50
03/01/2000	21:15:00	436.74	-0.18	69.99	1031.39
03/01/2000	21:30:00	437.26	-0.24	69.32	1015.02
03/01/2000	21:45:00	437.87	-0.28	68.80	999.04
03/01/2000	22:00:00	438.59	-0.31	67.54	983.25
03/01/2000	22:15:00	439.42	-0.33	66.89	967.98
03/01/2000	22:30:00	440.48	-0.34	66.84	953.39
03/01/2000	22:45:00	441.89	-0.35	67.22	939.16
03/01/2000	23:00:00	443.52	-0.36	68.73	925.58
03/01/2000	23:15:00	445.38	-0.36	63.20	912.32
03/01/2000	23:30:00	447.43	-0.34	63.38	899.61
03/01/2000	23:45:00	449.64	-0.31	63.33	887.14
04/01/2000	00:00:00	451.96	-0.27	62.52	875.12
04/01/2000	00:15:00	454.35	-0.22	62.19	863.31
04/01/2000	00:30:00	456.77	-0.16	61.63	851.79
04/01/2000	00:45:00	459.18	-0.09	61.11	840.43
04/01/2000	01:00:00	461.58	0.00	60.66	829.37
04/01/2000	01:15:00	464.02	0.11	60.18	818.38
04/01/2000	01:30:00	466.51	0.23	59.81	807.44
04/01/2000	01:45:00	469.01	0.34	59.36	796.41
04/01/2000	02:00:00	471.52	0.45	58.88	785.39
04/01/2000	02:15:00	474.02	0.57	58.43	774.28
04/01/2000	02:30:00	476.48	0.71	57.96	763.07
04/01/2000	02:45:00	478.90	0.84	57.48	751.70
04/01/2000	03:00:00	481.26	0.95	57.00	740.17
04/01/2000	03:15:00	483.55	1.04	56.50	728.18
04/01/2000	03:30:00	485.76	1.10	56.00	718.73
04/01/2000	03:45:00	487.87	1.15	55.48	710.06
04/01/2000	04:00:00	489.89	1.19	54.95	700.74
04/01/2000	04:15:00	491.82	1.22	54.41	690.79
04/01/2000	04:30:00	493.64	1.22	53.85	680.61
04/01/2000	04:45:00	495.37	1.20	53.26	670.26
04/01/2000	05:00:00	497.01	1.15	52.66	659.86
04/01/2000	05:15:00	498.55	1.08	52.03	649.43
04/01/2000	05:30:00	500.01	1.01	51.38	639.16
04/01/2000	05:45:00	501.41	0.95	50.72	628.95
04/01/2000	06:00:00	502.74	0.88	50.04	618.91
04/01/2000	06:15:00	504.01	0.80	49.34	609.07
04/01/2000	06:30:00	505.22	0.71	48.64	599.41
04/01/2000	06:45:00	506.35	0.61	47.92	589.97
04/01/2000	07:00:00	507.42	0.51	47.19	580.80
04/01/2000	07:15:00	508.42	0.41	46.46	571.80
04/01/2000	07:30:00	509.30	0.31	45.72	563.09
04/01/2000	07:45:00	510.06	0.20	44.97	556.54
04/01/2000	08:00:00	510.72	0.09	44.25	549.91
04/01/2000	08:15:00	511.29	-0.03	43.51	547.84
04/01/2000	08:30:00	511.82	-0.15	42.77	536.99
04/01/2000	08:45:00	512.32	-0.25	37.37	526.81
04/01/2000	09:00:00	512.79	-0.35	42.34	518.08
04/01/2000	09:15:00	513.25	-0.42	40.72	509.86
04/01/2000	09:30:00	513.69	-0.49	39.60	502.09
04/01/2000	09:45:00	514.13	-0.54	39.51	494.60

Boundary Condition for return period of 25 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	10:00:00	514.57	-0.58	38.58	487.35
04/01/2000	10:15:00	515.01	-0.61	38.01	480.24
04/01/2000	10:30:00	515.45	-0.64	37.41	473.34
04/01/2000	10:45:00	515.90	-0.66	36.78	466.85
04/01/2000	11:00:00	516.36	-0.67	36.21	461.53
04/01/2000	11:15:00	516.83	-0.68	35.66	456.48
04/01/2000	11:30:00	517.30	-0.69	35.12	450.97
04/01/2000	11:45:00	517.77	-0.70	34.62	445.42
04/01/2000	12:00:00	518.25	-0.70	34.14	439.72
04/01/2000	12:15:00	518.73	-0.70	33.68	434.02
04/01/2000	12:30:00	519.21	-0.68	33.25	429.24
04/01/2000	12:45:00	519.69	-0.65	32.84	424.85
04/01/2000	13:00:00	520.17	-0.60	32.45	420.09
04/01/2000	13:15:00	520.65	-0.54	32.09	415.42
04/01/2000	13:30:00	521.12	-0.47	31.76	411.13
04/01/2000	13:45:00	521.60	-0.36	31.45	406.36
04/01/2000	14:00:00	522.08	-0.22	31.17	401.58
04/01/2000	14:15:00	522.55	-0.08	30.91	396.88
04/01/2000	14:30:00	523.02	0.04	30.69	392.13
04/01/2000	14:45:00	523.48	0.17	30.48	387.35
04/01/2000	15:00:00	523.95	0.30	30.31	382.53
04/01/2000	15:15:00	524.41	0.43	30.16	377.59
04/01/2000	15:30:00	524.87	0.55	30.05	372.71
04/01/2000	15:45:00	525.32	0.66	29.96	367.84
04/01/2000	16:00:00	525.77	0.73	29.90	362.97
04/01/2000	16:15:00	526.22	0.78	29.86	358.10
04/01/2000	16:30:00	526.66	0.81	29.85	353.79
04/01/2000	16:45:00	527.11	0.84	29.86	349.68
04/01/2000	17:00:00	527.55	0.86	29.90	346.44
04/01/2000	17:15:00	527.98	0.86	29.98	343.22
04/01/2000	17:30:00	528.42	0.85	30.03	340.48
04/01/2000	17:45:00	528.85	0.81	30.11	338.09
04/01/2000	18:00:00	529.28	0.78	30.21	335.98
04/01/2000	18:15:00	529.70	0.74	30.32	334.12
04/01/2000	18:30:00	530.12	0.71	30.44	332.66
04/01/2000	18:45:00	530.53	0.68	30.56	331.43
04/01/2000	19:00:00	530.93	0.63	30.69	330.42
04/01/2000	19:15:00	531.33	0.57	30.83	329.44
04/01/2000	19:30:00	531.71	0.49	30.96	328.42
04/01/2000	19:45:00	532.08	0.41	31.09	327.24
04/01/2000	20:00:00	532.44	0.32	31.22	325.98
04/01/2000	20:15:00	532.78	0.23	31.35	324.65
04/01/2000	20:30:00	533.10	0.14	31.47	323.32
04/01/2000	20:45:00	533.40	0.04	31.59	321.99
04/01/2000	21:00:00	533.67	-0.07	31.69	320.58
04/01/2000	21:15:00	533.92	-0.18	31.79	319.47
04/01/2000	21:30:00	534.15	-0.28	31.87	318.61
04/01/2000	21:45:00	534.34	-0.36	31.94	317.97
04/01/2000	22:00:00	534.49	-0.43	31.99	316.33
04/01/2000	22:15:00	534.61	-0.48	32.02	314.24

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	22:30:00	534.69	-0.52	32.04	311.93
04/01/2000	22:45:00	534.73	-0.56	32.03	309.54
04/01/2000	23:00:00	534.73	-0.58	32.00	306.17
04/01/2000	23:15:00	534.68	-0.58	31.94	302.52
04/01/2000	23:30:00	534.59	-0.56	31.86	298.85
04/01/2000	23:45:00	534.46	-0.52	31.75	295.18
05/01/2000	00:00:00	534.28	-0.48	31.62	291.55
05/01/2000	00:15:00	534.07	-0.44	31.46	287.93
05/01/2000	00:30:00	533.81	-0.40	31.28	284.30
05/01/2000	00:45:00	533.51	-0.34	31.07	280.66
05/01/2000	01:00:00	533.18	-0.26	30.84	277.04
05/01/2000	01:15:00	532.81	-0.17	30.58	273.47
05/01/2000	01:30:00	532.41	-0.08	30.31	269.97
05/01/2000	01:45:00	531.97	0.00	30.04	266.44
05/01/2000	02:00:00	531.51	0.09	29.73	262.76
05/01/2000	02:15:00	531.01	0.21	29.40	258.93
05/01/2000	02:30:00	530.49	0.34	29.07	255.07
05/01/2000	02:45:00	529.95	0.48	28.72	251.21
05/01/2000	03:00:00	529.38	0.62	28.36	246.99
05/01/2000	03:15:00	528.80	0.73	27.99	241.92
05/01/2000	03:30:00	528.20	0.83	27.61	235.57
05/01/2000	03:45:00	527.58	0.92	27.23	228.18
05/01/2000	04:00:00	526.95	1.01	26.84	221.64
05/01/2000	04:15:00	526.31	1.08	26.44	218.30
05/01/2000	04:30:00	525.66	1.12	26.04	216.56
05/01/2000	04:45:00	525.01	1.13	25.65	214.13
05/01/2000	05:00:00	524.35	1.13	25.25	208.69
05/01/2000	05:15:00	523.69	1.10	24.85	203.92
05/01/2000	05:30:00	523.03	1.07	24.44	201.40
05/01/2000	05:45:00	522.37	1.04	24.04	201.69
05/01/2000	06:00:00	521.71	1.00	23.65	203.78
05/01/2000	06:15:00	521.05	0.95	23.25	205.95
05/01/2000	06:30:00	520.39	0.88	22.86	206.99
05/01/2000	06:45:00	519.73	0.80	22.48	207.29
05/01/2000	07:00:00	519.07	0.73	22.10	206.52
05/01/2000	07:15:00	518.42	0.66	21.72	205.24
05/01/2000	07:30:00	517.77	0.58	21.36	204.20
05/01/2000	07:45:00	517.12	0.49	21.00	203.40
05/01/2000	08:00:00	516.47	0.38	20.65	202.16
05/01/2000	08:15:00	515.83	0.25	20.30	200.36
05/01/2000	08:30:00	515.19	0.12	19.97	198.31
05/01/2000	08:45:00	514.55	-0.01	19.65	197.85
05/01/2000	09:00:00	513.90	-0.13	19.34	200.25
05/01/2000	09:15:00	513.27	-0.25	19.04	200.81
05/01/2000	09:30:00	512.63	-0.37	18.75	199.02
05/01/2000	09:45:00	511.99	-0.47	18.47	195.39
05/01/2000	10:00:00	511.35	-0.57	18.21	191.31
05/01/2000	10:15:00	510.71	-0.65	17.96	187.09
05/01/2000	10:30:00	510.07	-0.72	17.73	182.79
05/01/2000	10:45:00	509.43	-0.77	17.51	178.56

Boundary Condition for return period of 25 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	11:00:00	508.80	-0.80	17.29	174.34
05/01/2000	11:15:00	508.16	-0.83	17.09	170.18
05/01/2000	11:30:00	507.52	-0.86	16.90	166.16
05/01/2000	11:45:00	506.89	-0.87	16.71	162.24
05/01/2000	12:00:00	506.26	-0.88	16.54	158.43
05/01/2000	12:15:00	505.65	-0.88	16.37	154.71
05/01/2000	12:30:00	505.04	-0.86	16.20	151.10
05/01/2000	12:45:00	504.42	-0.83	16.04	147.61
05/01/2000	13:00:00	503.81	-0.81	15.89	144.27
05/01/2000	13:15:00	503.19	-0.77	15.75	140.94
05/01/2000	13:30:00	502.57	-0.73	15.62	137.63
05/01/2000	13:45:00	501.94	-0.65	15.49	134.35
05/01/2000	14:00:00	501.31	-0.55	15.39	131.12
05/01/2000	14:15:00	500.67	-0.46	15.28	127.93
05/01/2000	14:30:00	499.99	-0.36	15.13	124.74
05/01/2000	14:45:00	499.22	-0.25	15.03	121.42
05/01/2000	15:00:00	498.39	-0.13	14.91	117.77
05/01/2000	15:15:00	497.56	0.01	14.79	113.80
05/01/2000	15:30:00	496.73	0.16	14.73	109.50
05/01/2000	15:45:00	495.90	0.29	14.63	104.36
05/01/2000	16:00:00	495.08	0.39	14.51	96.77
05/01/2000	16:15:00	494.27	0.47	14.44	83.47
05/01/2000	16:30:00	493.47	0.54	14.34	62.56
05/01/2000	16:45:00	492.67	0.61	14.25	50.10
05/01/2000	17:00:00	491.87	0.66	14.16	53.32
05/01/2000	17:15:00	491.08	0.69	14.08	58.41
05/01/2000	17:30:00	490.29	0.70	13.99	61.06

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	17:45:00	489.50	0.69	13.91	64.85
05/01/2000	18:00:00	488.71	0.68	13.83	70.69
05/01/2000	18:15:00	487.92	0.68	13.76	77.16
05/01/2000	18:30:00	487.14	0.68	13.69	82.23
05/01/2000	18:45:00	486.35	0.68	13.62	84.41
05/01/2000	19:00:00	485.57	0.66	13.55	83.38
05/01/2000	19:15:00	484.78	0.63	13.49	80.44
05/01/2000	19:30:00	484.00	0.59	13.43	77.48
05/01/2000	19:45:00	483.21	0.54	13.37	75.93
05/01/2000	20:00:00	482.42	0.50	13.31	77.06
05/01/2000	20:15:00	481.64	0.44	13.26	79.57
05/01/2000	20:30:00	480.85	0.36	13.21	81.07
05/01/2000	20:45:00	480.06	0.26	13.17	81.26
05/01/2000	21:00:00	479.28	0.15	13.12	80.95
05/01/2000	21:15:00	478.49	0.04	13.08	81.39
05/01/2000	21:30:00	477.71	-0.07	13.04	82.45
05/01/2000	21:45:00	476.92	-0.16	13.03	83.36
05/01/2000	22:00:00	476.14	-0.25	12.98	83.70
05/01/2000	22:15:00	475.36	-0.33	12.94	83.15
05/01/2000	22:30:00	474.59	-0.41	12.92	81.87
05/01/2000	22:45:00	473.83	-0.47	12.88	80.20
05/01/2000	23:00:00	473.07	-0.51	12.86	78.52
05/01/2000	23:15:00	472.33	-0.54	12.83	76.63
05/01/2000	23:30:00	471.59	-0.53	12.80	74.69
05/01/2000	23:45:00	470.86	-0.51	12.78	72.70
06/01/2000	00:00:00	470.13	-0.50	12.75	70.56

10.11. Boundary Condition for return period of 50 years

Date	Time	Bicol	Bay	Naga	Libmanan
01/01/2000	00:00:00	0.00	0.00	0.00	0.00
01/01/2000	12:15:00	62.05	0.00	10.43	9.37
01/01/2000	12:30:00	62.20	0.20	11.72	22.61
01/01/2000	12:45:00	62.44	0.40	12.02	22.70
01/01/2000	13:00:00	61.33	0.46	12.07	23.70
01/01/2000	13:15:00	60.51	0.56	12.16	11.53
01/01/2000	13:30:00	59.86	0.68	12.40	-40.82
01/01/2000	13:45:00	59.39	0.76	12.86	-41.38
01/01/2000	14:00:00	58.98	0.84	11.24	-34.00
01/01/2000	14:15:00	58.53	0.91	12.18	-35.07
01/01/2000	14:30:00	57.26	0.97	11.78	-38.88
01/01/2000	14:45:00	52.99	0.98	11.63	-34.40
01/01/2000	15:00:00	48.70	0.99	11.88	-26.10
01/01/2000	15:15:00	44.53	0.99	12.18	-20.39
01/01/2000	15:30:00	41.22	0.97	12.03	-3.39
01/01/2000	15:45:00	37.77	0.94	12.28	24.68
01/01/2000	16:00:00	34.32	0.90	12.61	42.40
01/01/2000	16:15:00	32.40	0.85	12.90	48.47
01/01/2000	16:30:00	30.74	0.75	13.31	55.22
01/01/2000	16:45:00	29.92	0.66	13.63	63.13
01/01/2000	17:00:00	31.28	0.57	14.02	75.04
01/01/2000	17:15:00	34.42	0.49	14.38	82.33
01/01/2000	17:30:00	39.34	0.41	14.58	83.77
01/01/2000	17:45:00	44.76	0.32	14.66	84.01
01/01/2000	18:00:00	49.08	0.22	15.41	83.55
01/01/2000	18:15:00	53.56	0.12	15.14	82.97
01/01/2000	18:30:00	56.85	0.02	15.37	82.43
01/01/2000	18:45:00	58.89	-0.07	15.72	83.15
01/01/2000	19:00:00	60.45	-0.14	15.96	84.08
01/01/2000	19:15:00	61.94	-0.24	16.21	85.15
01/01/2000	19:30:00	63.15	-0.33	16.52	85.97
01/01/2000	19:45:00	63.82	-0.42	16.84	86.67
01/01/2000	20:00:00	64.58	-0.51	17.13	87.31
01/01/2000	20:15:00	65.45	-0.59	17.49	88.19
01/01/2000	20:30:00	66.23	-0.64	17.82	89.24
01/01/2000	20:45:00	67.00	-0.69	18.19	90.53
01/01/2000	21:00:00	67.80	-0.75	18.54	91.98
01/01/2000	21:15:00	68.78	-0.78	18.97	93.54
01/01/2000	21:30:00	69.73	-0.80	19.41	95.28
01/01/2000	21:45:00	70.74	-0.79	19.82	97.31
01/01/2000	22:00:00	71.45	-0.76	20.25	99.64
01/01/2000	22:15:00	72.22	-0.67	20.71	102.20
01/01/2000	22:30:00	72.89	-0.60	21.19	104.93
01/01/2000	22:45:00	74.14	-0.50	21.67	107.91
01/01/2000	23:00:00	75.53	-0.43	22.19	111.17
01/01/2000	23:15:00	76.73	-0.31	22.73	114.66
01/01/2000	23:30:00	77.91	-0.20	23.27	118.73
01/01/2000	23:45:00	79.03	-0.08	23.80	125.88
02/01/2000	00:00:00	79.96	0.06	24.37	136.01
02/01/2000	00:15:00	80.98	0.19	24.96	141.43
02/01/2000	00:30:00	82.11	0.31	25.65	136.97
02/01/2000	00:45:00	83.31	0.42	26.57	127.49
02/01/2000	01:00:00	84.49	0.54	27.15	119.04
02/01/2000	01:15:00	85.67	0.68	27.23	114.96
02/01/2000	01:30:00	86.76	0.78	27.19	117.71
02/01/2000	01:45:00	87.63	0.88	27.78	121.69
02/01/2000	02:00:00	88.01	0.96	28.32	123.54
02/01/2000	02:15:00	88.01	1.01	28.69	128.65
02/01/2000	02:30:00	87.29	1.08	29.03	146.14
02/01/2000	02:45:00	84.72	1.11	30.18	168.93
02/01/2000	03:00:00	81.67	1.15	30.56	201.13
02/01/2000	03:15:00	78.64	1.14	30.19	205.05
02/01/2000	03:30:00	79.06	1.13	31.23	191.77
02/01/2000	03:45:00	80.24	1.06	32.19	174.25
02/01/2000	04:00:00	80.43	1.00	32.51	172.63
02/01/2000	04:15:00	84.10	0.93	31.84	179.37
02/01/2000	04:30:00	87.64	0.86	31.87	191.69
02/01/2000	04:45:00	90.21	0.75	33.39	199.71
02/01/2000	05:00:00	95.11	0.66	32.98	203.41
02/01/2000	05:15:00	100.31	0.56	32.23	205.64
02/01/2000	05:30:00	105.60	0.44	30.92	200.52
02/01/2000	05:45:00	106.12	0.31	30.99	210.56
02/01/2000	06:00:00	104.11	0.22	33.42	225.21
02/01/2000	06:15:00	100.19	0.12	34.60	229.32
02/01/2000	06:30:00	96.75	0.00	33.54	229.72
02/01/2000	06:45:00	98.47	-0.10	33.43	229.23
02/01/2000	07:00:00	99.93	-0.22	33.16	229.13
02/01/2000	07:15:00	100.91	-0.33	33.05	228.76
02/01/2000	07:30:00	102.46	-0.44	32.95	228.58
02/01/2000	07:45:00	103.65	-0.52	32.78	228.62

Boundary Condition for return period of 50 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
02/01/2000	08:00:00	104.74	-0.62	32.63	229.01
02/01/2000	08:15:00	105.78	-0.69	32.55	229.77
02/01/2000	08:30:00	107.18	-0.77	32.49	230.70
02/01/2000	08:45:00	108.54	-0.84	32.43	231.92
02/01/2000	09:00:00	110.02	-0.89	32.37	233.43
02/01/2000	09:15:00	111.50	-0.94	32.39	235.22
02/01/2000	09:30:00	113.03	-0.97	32.41	237.41
02/01/2000	09:45:00	115.28	-1.00	32.46	240.03
02/01/2000	10:00:00	118.56	-1.02	32.58	243.05
02/01/2000	10:15:00	123.68	-1.04	32.69	246.38
02/01/2000	10:30:00	125.76	-1.04	32.91	249.99
02/01/2000	10:45:00	126.78	-0.99	33.12	253.91
02/01/2000	11:00:00	127.89	-0.88	33.32	258.15
02/01/2000	11:15:00	129.01	-0.78	33.56	262.68
02/01/2000	11:30:00	129.81	-0.68	33.86	267.50
02/01/2000	11:45:00	130.51	-0.56	34.21	272.57
02/01/2000	12:00:00	131.38	-0.45	34.59	277.84
02/01/2000	12:15:00	132.41	-0.32	35.12	283.47
02/01/2000	12:30:00	133.74	-0.18	35.81	290.94
02/01/2000	12:45:00	135.51	-0.05	36.70	301.22
02/01/2000	13:00:00	137.61	0.09	37.79	316.27
02/01/2000	13:15:00	140.06	0.22	39.25	335.82
02/01/2000	13:30:00	142.71	0.33	41.18	353.37
02/01/2000	13:45:00	145.79	0.47	43.64	369.01
02/01/2000	14:00:00	149.32	0.59	46.30	390.25
02/01/2000	14:15:00	153.59	0.71	48.89	416.92
02/01/2000	14:30:00	158.51	0.81	52.36	451.83
02/01/2000	14:45:00	164.33	0.89	56.31	493.72
02/01/2000	15:00:00	170.80	0.94	60.70	548.35
02/01/2000	15:15:00	178.62	0.99	66.97	617.30
02/01/2000	15:30:00	187.65	1.04	72.72	697.65
02/01/2000	15:45:00	197.58	1.04	79.72	777.19
02/01/2000	16:00:00	209.46	1.04	89.28	861.69
02/01/2000	16:15:00	222.79	0.99	97.03	947.18
02/01/2000	16:30:00	242.42	0.94	104.80	1042.19
02/01/2000	16:45:00	270.79	0.88	114.76	1154.81
02/01/2000	17:00:00	299.29	0.81	124.95	1300.92
02/01/2000	17:15:00	328.78	0.77	135.97	1456.20
02/01/2000	17:30:00	358.15	0.71	148.11	1583.72
02/01/2000	17:45:00	388.27	0.65	161.04	1712.80
02/01/2000	18:00:00	418.71	0.56	174.67	1841.18
02/01/2000	18:15:00	447.79	0.46	191.05	1979.13
02/01/2000	18:30:00	453.62	0.39	207.92	2117.43
02/01/2000	18:45:00	426.06	0.31	225.25	2250.63
02/01/2000	19:00:00	421.33	0.22	243.28	2373.91
02/01/2000	19:15:00	433.54	0.15	261.75	2494.78
02/01/2000	19:30:00	444.89	0.05	280.37	2616.44
02/01/2000	19:45:00	458.36	-0.04	299.49	2748.48
02/01/2000	20:00:00	478.43	-0.11	318.90	2879.41
02/01/2000	20:15:00	503.68	-0.19	338.39	2997.02

Date	Time	Bicol	Bay	Naga	Libmanan
02/01/2000	20:30:00	526.90	-0.23	357.86	3103.33
02/01/2000	20:45:00	554.81	-0.28	377.22	3201.96
02/01/2000	21:00:00	586.10	-0.31	396.55	3303.96
02/01/2000	21:15:00	626.41	-0.35	415.74	3389.65
02/01/2000	21:30:00	691.94	-0.36	434.46	3469.10
02/01/2000	21:45:00	763.08	-0.36	452.54	3541.47
02/01/2000	22:00:00	820.77	-0.36	470.25	3606.32
02/01/2000	22:15:00	859.14	-0.37	487.04	3661.95
02/01/2000	22:30:00	883.83	-0.36	503.43	3713.41
02/01/2000	22:45:00	901.84	-0.37	518.72	3760.11
02/01/2000	23:00:00	918.44	-0.34	533.52	3802.66
02/01/2000	23:15:00	933.62	-0.31	546.96	3839.89
02/01/2000	23:30:00	948.10	-0.27	559.76	3873.32
02/01/2000	23:45:00	961.34	-0.20	570.85	3903.82
03/01/2000	00:00:00	973.36	-0.10	581.23	3934.72
03/01/2000	00:15:00	986.93	-0.01	589.95	3962.47
03/01/2000	00:30:00	1002.95	0.09	598.02	3987.75
03/01/2000	00:45:00	1007.64	0.18	604.34	4011.10
03/01/2000	01:00:00	1006.75	0.30	610.00	4032.71
03/01/2000	01:15:00	1013.23	0.44	614.10	4053.20
03/01/2000	01:30:00	1015.17	0.57	617.58	4072.18
03/01/2000	01:45:00	1015.18	0.67	619.53	4089.81
03/01/2000	02:00:00	1010.72	0.78	620.93	4106.39
03/01/2000	02:15:00	1036.67	0.88	620.94	4121.89
03/01/2000	02:30:00	1065.98	0.98	620.63	4135.01
03/01/2000	02:45:00	1082.14	1.08	618.86	4146.44
03/01/2000	03:00:00	1088.03	1.15	615.72	4155.04
03/01/2000	03:15:00	1085.24	1.20	612.06	4161.57
03/01/2000	03:30:00	1075.44	1.22	607.64	4165.15
03/01/2000	03:45:00	1060.86	1.22	602.04	4167.60
03/01/2000	04:00:00	1043.55	1.21	595.93	4167.16
03/01/2000	04:15:00	1025.35	1.17	588.65	4165.14
03/01/2000	04:30:00	1007.23	1.18	580.97	4160.85
03/01/2000	04:45:00	989.93	2.14	572.11	4154.99
03/01/2000	05:00:00	973.57	2.82	562.89	4146.27
03/01/2000	05:15:00	958.39	3.16	552.68	4136.08
03/01/2000	05:30:00	944.64	3.80	542.12	4123.70
03/01/2000	05:45:00	932.22	4.07	530.99	4110.08
03/01/2000	06:00:00	920.79	4.27	519.75	4094.30
03/01/2000	06:15:00	910.12	4.64	508.05	4077.47
03/01/2000	06:30:00	899.96	4.85	496.21	4058.74
03/01/2000	06:45:00	890.02	4.94	484.13	4038.93
03/01/2000	07:00:00	880.16	5.04	471.93	4017.43
03/01/2000	07:15:00	870.22	5.07	459.57	3995.51
03/01/2000	07:30:00	860.18	5.02	447.23	3971.90
03/01/2000	07:45:00	850.11	4.91	434.85	3947.03
03/01/2000	08:00:00	840.06	4.77	422.42	3920.64
03/01/2000	08:15:00	830.00	4.56	410.04	3893.28
03/01/2000	08:30:00	819.86	4.26	397.66	3863.74
03/01/2000	08:45:00	809.57	3.89	388.63	3834.08

Boundary Condition for return period of 50 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
03/01/2000	09:00:00	799.17	3.48	373.36	3804.02
03/01/2000	09:15:00	788.57	3.06	358.75	3774.33
03/01/2000	09:30:00	777.85	2.72	350.42	3743.91
03/01/2000	09:45:00	766.90	2.36	339.65	3713.17
03/01/2000	10:00:00	761.43	2.03	329.34	3680.58
03/01/2000	10:15:00	769.21	1.73	319.12	3646.28
03/01/2000	10:30:00	774.08	1.45	309.55	3609.84
03/01/2000	10:45:00	775.90	1.24	300.62	3572.12
03/01/2000	11:00:00	776.34	1.06	291.53	3532.53
03/01/2000	11:15:00	776.39	0.93	282.83	3492.12
03/01/2000	11:30:00	775.52	0.83	274.33	3449.96
03/01/2000	11:45:00	775.07	0.75	266.23	3406.73
03/01/2000	12:00:00	782.13	0.69	258.27	3362.22
03/01/2000	12:15:00	782.93	0.63	250.65	3316.44
03/01/2000	12:30:00	779.69	0.59	243.13	3268.63
03/01/2000	12:45:00	780.11	0.57	235.95	3221.07
03/01/2000	13:00:00	786.44	0.55	229.08	3173.11
03/01/2000	13:15:00	783.84	0.51	222.44	3124.62
03/01/2000	13:30:00	775.74	0.53	215.88	3070.32
03/01/2000	13:45:00	771.13	0.41	209.73	3014.72
03/01/2000	14:00:00	767.59	0.60	203.89	2963.11
03/01/2000	14:15:00	763.84	0.53	198.28	2915.74
03/01/2000	14:30:00	760.18	0.57	192.83	2872.89
03/01/2000	14:45:00	756.62	0.77	187.65	2826.09
03/01/2000	15:00:00	753.16	0.81	182.66	2780.21
03/01/2000	15:15:00	749.93	0.83	178.47	2731.36
03/01/2000	15:30:00	746.81	0.95	173.55	2682.61
03/01/2000	15:45:00	743.81	1.04	169.40	2633.83
03/01/2000	16:00:00	740.97	1.03	165.73	2584.89
03/01/2000	16:15:00	738.27	1.05	162.00	2534.69
03/01/2000	16:30:00	735.72	1.08	158.14	2485.14
03/01/2000	16:45:00	733.36	1.04	154.94	2437.96
03/01/2000	17:00:00	731.24	1.01	151.20	2391.42
03/01/2000	17:15:00	729.27	0.99	147.93	2343.45
03/01/2000	17:30:00	727.41	0.97	144.84	2294.79
03/01/2000	17:45:00	725.70	0.92	141.77	2246.60
03/01/2000	18:00:00	724.10	0.86	138.81	2199.68
03/01/2000	18:15:00	722.65	0.81	136.09	2153.74
03/01/2000	18:30:00	721.28	0.74	133.44	2109.39
03/01/2000	18:45:00	720.01	0.68	130.96	2065.94
03/01/2000	19:00:00	718.86	0.63	128.54	2023.58
03/01/2000	19:15:00	717.88	0.56	126.19	1981.04
03/01/2000	19:30:00	717.09	0.49	123.79	1940.96
03/01/2000	19:45:00	716.46	0.42	121.65	1902.87
03/01/2000	20:00:00	716.10	0.35	119.66	1866.39
03/01/2000	20:15:00	715.96	0.26	117.77	1830.26
03/01/2000	20:30:00	716.02	0.22	115.80	1796.54
03/01/2000	20:45:00	716.36	0.16	113.99	1764.75
03/01/2000	21:00:00	717.08	0.12	112.28	1734.34
03/01/2000	21:15:00	718.05	0.09	110.69	1705.17
03/01/2000	21:30:00	719.17	0.06	109.54	1677.51
03/01/2000	21:45:00	720.47	0.04	108.69	1650.62
03/01/2000	22:00:00	721.98	0.02	106.22	1623.95
03/01/2000	22:15:00	723.72	0.02	104.23	1597.81
03/01/2000	22:30:00	725.94	0.01	104.82	1572.86
03/01/2000	22:45:00	728.72	-0.01	105.98	1549.03
03/01/2000	23:00:00	731.96	-0.04	109.41	1526.57
03/01/2000	23:15:00	735.90	-0.08	98.02	1504.40
03/01/2000	23:30:00	740.24	-0.10	98.62	1481.46
03/01/2000	23:45:00	744.82	-0.12	98.76	1461.65
04/01/2000	00:00:00	749.27	-0.13	97.25	1442.47
04/01/2000	00:15:00	754.17	-0.10	96.74	1423.16
04/01/2000	00:30:00	759.43	-0.06	95.76	1404.08
04/01/2000	00:45:00	764.65	-0.01	94.91	1385.30
04/01/2000	01:00:00	769.86	0.06	94.21	1367.16
04/01/2000	01:15:00	775.16	0.15	93.44	1349.18
04/01/2000	01:30:00	780.58	0.27	92.90	1331.20
04/01/2000	01:45:00	786.01	0.37	92.21	1313.26
04/01/2000	02:00:00	791.47	0.48	91.51	1295.90
04/01/2000	02:15:00	796.91	0.59	90.97	1279.37
04/01/2000	02:30:00	802.28	0.73	90.56	1263.82
04/01/2000	02:45:00	807.59	0.86	90.34	1247.96
04/01/2000	03:00:00	812.82	0.96	90.13	1232.55
04/01/2000	03:15:00	817.96	1.05	89.56	1218.11
04/01/2000	03:30:00	823.08	1.11	89.09	1207.73
04/01/2000	03:45:00	828.23	1.16	88.30	1193.39
04/01/2000	04:00:00	833.22	1.20	87.27	1175.12
04/01/2000	04:15:00	838.04	1.24	83.93	1157.82
04/01/2000	04:30:00	842.83	1.23	83.43	1141.55
04/01/2000	04:45:00	847.27	1.21	83.03	1121.80
04/01/2000	05:00:00	851.21	1.16	81.70	1101.78
04/01/2000	05:15:00	855.11	1.09	80.65	1082.23
04/01/2000	05:30:00	858.80	1.02	79.54	1063.55
04/01/2000	05:45:00	862.40	0.97	78.20	1043.38
04/01/2000	06:00:00	865.88	0.89	77.05	1021.00
04/01/2000	06:15:00	869.24	0.82	75.72	998.19
04/01/2000	06:30:00	872.42	0.73	74.14	977.57
04/01/2000	06:45:00	875.39	0.64	72.66	958.97
04/01/2000	07:00:00	878.19	0.55	71.14	942.54
04/01/2000	07:15:00	880.78	0.45	69.78	926.77
04/01/2000	07:30:00	882.98	0.36	68.39	909.81
04/01/2000	07:45:00	884.83	0.26	67.25	894.31
04/01/2000	08:00:00	886.39	0.16	65.89	880.13
04/01/2000	08:15:00	887.75	0.06	64.14	879.60
04/01/2000	08:30:00	889.03	-0.04	63.09	861.40
04/01/2000	08:45:00	890.28	-0.11	51.99	844.38
04/01/2000	09:00:00	891.46	-0.21	62.92	830.41
04/01/2000	09:15:00	892.58	-0.24	59.85	817.24
04/01/2000	09:30:00	893.69	-0.29	56.42	805.14
04/01/2000	09:45:00	894.82	-0.31	57.30	793.82

Boundary Condition for return period of 50 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
04/01/2000	10:00:00	895.71	-0.32	56.01	783.06
04/01/2000	10:15:00	896.48	-0.32	55.17	772.68
04/01/2000	10:30:00	897.53	-0.33	54.34	762.85
04/01/2000	10:45:00	898.60	-0.33	53.43	753.75
04/01/2000	11:00:00	899.97	-0.33	52.60	746.91
04/01/2000	11:15:00	901.42	-0.33	51.77	740.53
04/01/2000	11:30:00	902.91	-0.35	51.03	733.07
04/01/2000	11:45:00	904.36	-0.38	50.30	725.39
04/01/2000	12:00:00	905.79	-0.40	49.60	717.25
04/01/2000	12:15:00	907.19	-0.47	48.93	709.02
04/01/2000	12:30:00	908.58	-0.51	48.30	702.59
04/01/2000	12:45:00	909.95	-0.53	47.70	696.87
04/01/2000	13:00:00	911.34	-0.51	47.13	690.27
04/01/2000	13:15:00	912.71	-0.47	46.66	683.80
04/01/2000	13:30:00	914.07	-0.42	46.21	678.07
04/01/2000	13:45:00	915.45	-0.33	45.81	671.34
04/01/2000	14:00:00	916.82	-0.17	45.46	664.57
04/01/2000	14:15:00	918.17	-0.03	45.15	657.97
04/01/2000	14:30:00	919.49	0.07	44.93	651.43
04/01/2000	14:45:00	920.75	0.20	44.76	645.76
04/01/2000	15:00:00	922.03	0.33	44.73	643.00
04/01/2000	15:15:00	923.40	0.45	44.95	642.69
04/01/2000	15:30:00	924.83	0.56	45.54	642.98
04/01/2000	15:45:00	926.18	0.67	46.32	644.07
04/01/2000	16:00:00	927.51	0.73	46.82	646.59
04/01/2000	16:15:00	928.87	0.78	47.26	648.08
04/01/2000	16:30:00	930.29	0.81	47.34	646.05
04/01/2000	16:45:00	931.85	0.84	47.12	635.62
04/01/2000	17:00:00	933.60	0.86	46.44	618.91
04/01/2000	17:15:00	935.51	0.86	46.42	599.67
04/01/2000	17:30:00	937.94	0.85	46.00	585.48
04/01/2000	17:45:00	940.01	0.81	46.03	577.02
04/01/2000	18:00:00	941.86	0.79	46.09	569.74
04/01/2000	18:15:00	943.71	0.75	45.93	562.06
04/01/2000	18:30:00	945.47	0.72	45.57	553.51
04/01/2000	18:45:00	947.05	0.69	45.34	548.10
04/01/2000	19:00:00	948.35	0.64	45.59	545.22
04/01/2000	19:15:00	949.37	0.59	45.97	544.79
04/01/2000	19:30:00	950.10	0.51	46.34	545.07
04/01/2000	19:45:00	950.75	0.43	46.86	544.43
04/01/2000	20:00:00	951.44	0.34	47.20	542.57
04/01/2000	20:15:00	952.12	0.26	47.38	539.63
04/01/2000	20:30:00	952.80	0.18	47.54	536.67
04/01/2000	20:45:00	953.26	0.09	47.74	534.22
04/01/2000	21:00:00	953.67	-0.02	47.92	532.29
04/01/2000	21:15:00	954.18	-0.12	48.11	531.40
04/01/2000	21:30:00	954.63	-0.21	48.29	531.21
04/01/2000	21:45:00	955.06	-0.28	48.41	531.52
04/01/2000	22:00:00	955.41	-0.35	48.58	529.72
04/01/2000	22:15:00	955.67	-0.39	48.67	527.30
04/01/2000	22:30:00	955.83	-0.42	48.74	524.72
04/01/2000	22:45:00	955.86	-0.47	48.77	522.17
04/01/2000	23:00:00	955.61	-0.49	48.72	517.69
04/01/2000	23:15:00	954.92	-0.49	48.68	512.71
04/01/2000	23:30:00	953.09	-0.50	48.58	507.63
04/01/2000	23:45:00	952.52	-0.48	48.36	502.48
05/01/2000	00:00:00	952.20	-0.44	48.15	497.33
05/01/2000	00:15:00	951.94	-0.40	47.91	492.09
05/01/2000	00:30:00	951.71	-0.37	47.70	486.87
05/01/2000	00:45:00	951.50	-0.32	47.30	481.79
05/01/2000	01:00:00	951.25	-0.24	46.96	476.83
05/01/2000	01:15:00	950.92	-0.14	46.09	471.90
05/01/2000	01:30:00	950.47	-0.05	46.14	467.26
05/01/2000	01:45:00	949.93	0.02	45.70	464.01
05/01/2000	02:00:00	949.39	0.10	45.26	464.93
05/01/2000	02:15:00	948.81	0.23	44.87	467.02
05/01/2000	02:30:00	948.20	0.36	44.66	467.62
05/01/2000	02:45:00	947.61	0.50	44.53	465.37
05/01/2000	03:00:00	946.97	0.64	44.34	462.94
05/01/2000	03:15:00	946.33	0.75	44.22	462.26
05/01/2000	03:30:00	945.74	0.84	44.16	462.14
05/01/2000	03:45:00	945.18	0.93	43.98	458.41
05/01/2000	04:00:00	944.77	1.02	43.65	450.54
05/01/2000	04:15:00	944.56	1.09	42.50	442.73
05/01/2000	04:30:00	944.73	1.12	41.38	432.17
05/01/2000	04:45:00	945.41	1.13	40.13	420.71
05/01/2000	05:00:00	946.71	1.14	39.29	397.10
05/01/2000	05:15:00	948.36	1.10	38.79	372.05
05/01/2000	05:30:00	949.65	1.07	37.27	358.97
05/01/2000	05:45:00	950.63	1.04	35.60	357.27
05/01/2000	06:00:00	951.33	1.00	34.65	354.59
05/01/2000	06:15:00	951.46	0.95	33.93	351.04
05/01/2000	06:30:00	950.85	0.88	33.03	346.55
05/01/2000	06:45:00	948.55	0.80	32.22	342.47
05/01/2000	07:00:00	946.26	0.74	30.87	338.11
05/01/2000	07:15:00	944.21	0.67	29.75	332.56
05/01/2000	07:30:00	941.63	0.59	28.31	322.18
05/01/2000	07:45:00	939.34	0.51	27.10	315.39
05/01/2000	08:00:00	936.91	0.40	26.46	314.80
05/01/2000	08:15:00	934.27	0.27	26.07	311.37
05/01/2000	08:30:00	931.95	0.15	25.65	309.18
05/01/2000	08:45:00	929.62	0.02	24.95	309.80
05/01/2000	09:00:00	927.30	-0.09	24.41	316.48
05/01/2000	09:15:00	925.38	-0.20	23.90	319.25
05/01/2000	09:30:00	923.74	-0.32	23.36	317.46
05/01/2000	09:45:00	922.03	-0.40	22.88	312.13
05/01/2000	10:00:00	920.33	-0.49	22.37	306.24
05/01/2000	10:15:00	918.60	-0.56	21.91	300.13
05/01/2000	10:30:00	916.85	-0.63	21.31	293.87
05/01/2000	10:45:00	914.88	-0.66	20.55	287.73

Boundary Condition for return period of 50 years (continue)

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	11:00:00	912.57	-0.68	20.67	281.63
05/01/2000	11:15:00	910.00	-0.70	20.23	275.61
05/01/2000	11:30:00	908.25	-0.74	19.92	269.79
05/01/2000	11:45:00	906.91	-0.74	19.61	264.06
05/01/2000	12:00:00	905.65	-0.75	19.38	258.44
05/01/2000	12:15:00	904.52	-0.78	19.14	252.93
05/01/2000	12:30:00	903.54	-0.79	18.89	247.54
05/01/2000	12:45:00	902.59	-0.77	18.68	242.27
05/01/2000	13:00:00	901.62	-0.77	18.49	237.20
05/01/2000	13:15:00	900.60	-0.72	18.26	232.06
05/01/2000	13:30:00	899.56	-0.70	18.09	226.84
05/01/2000	13:45:00	898.48	-0.62	17.95	221.61
05/01/2000	14:00:00	897.36	-0.51	17.86	216.45
05/01/2000	14:15:00	896.21	-0.43	17.74	211.32
05/01/2000	14:30:00	895.03	-0.33	17.49	206.15
05/01/2000	14:45:00	893.72	-0.22	17.32	201.15
05/01/2000	15:00:00	892.27	-0.10	17.16	197.60
05/01/2000	15:15:00	890.81	0.04	17.04	196.59
05/01/2000	15:30:00	889.36	0.19	17.10	198.97
05/01/2000	15:45:00	887.93	0.32	17.18	199.26
05/01/2000	16:00:00	886.53	0.41	17.44	193.03
05/01/2000	16:15:00	885.18	0.49	18.11	177.18
05/01/2000	16:30:00	883.90	0.55	18.84	144.68
05/01/2000	16:45:00	882.67	0.62	19.17	124.06
05/01/2000	17:00:00	881.53	0.67	18.93	132.24
05/01/2000	17:15:00	880.59	0.69	18.60	142.20
05/01/2000	17:30:00	879.95	0.70	18.19	143.87

Date	Time	Bicol	Bay	Naga	Libmanan
05/01/2000	17:45:00	879.61	0.69	17.97	145.47
05/01/2000	18:00:00	879.59	0.68	17.56	147.60
05/01/2000	18:15:00	879.74	0.68	17.05	145.08
05/01/2000	18:30:00	879.93	0.68	16.35	135.35
05/01/2000	18:45:00	880.10	0.68	15.46	122.51
05/01/2000	19:00:00	880.07	0.66	14.77	114.35
05/01/2000	19:15:00	879.15	0.63	14.68	110.47
05/01/2000	19:30:00	877.35	0.60	14.54	108.14
05/01/2000	19:45:00	875.07	0.54	14.25	106.53
05/01/2000	20:00:00	872.54	0.51	13.81	106.32
05/01/2000	20:15:00	870.18	0.45	13.48	108.19
05/01/2000	20:30:00	867.94	0.37	13.36	109.99
05/01/2000	20:45:00	865.72	0.27	13.32	110.50
05/01/2000	21:00:00	863.48	0.16	13.22	110.21
05/01/2000	21:15:00	861.26	0.06	13.14	109.92
05/01/2000	21:30:00	859.18	-0.06	12.99	110.08
05/01/2000	21:45:00	857.14	-0.14	12.86	110.34
05/01/2000	22:00:00	855.18	-0.23	12.69	110.54
05/01/2000	22:15:00	853.25	-0.30	12.58	109.84
05/01/2000	22:30:00	851.36	-0.38	12.51	108.31
05/01/2000	22:45:00	849.48	-0.44	12.48	106.45
05/01/2000	23:00:00	847.63	-0.47	12.46	104.79
05/01/2000	23:15:00	845.85	-0.51	12.45	102.77
05/01/2000	23:30:00	844.08	-0.50	12.42	100.59
05/01/2000	23:45:00	842.35	-0.49	12.48	98.24
06/01/2000	00:00:00	840.65	-0.49	12.48	95.58