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IMPROVEMENT OF RIVER NETWORK USING GLOBAL POSITIONING SYSTEM

R. Jha, Post-Doc Fellow, IIS, University of Tokyo, 7-22-1, Roppongi, Minato-ku, Tokyo-106, Regular Member
S. Herath, Professor, IIS, University of Tokyo, 7-22-1, Roppongi, Minato-ku, Tokyo-106, Regular Member
K. Musiake, Professor, IIS, University of Tokyo, 7-22-1, Roppongi, Minato-ku, Tokyo-106, Regular Member

INTRODUCTION

To understand the global water circulation in different phases in land and atmosphere at macro scale, physically based distributed catchment models are needed. Digital elevation model (DEM) is the vital input data to the distributed hydrological model. Now a days more and more global data is available at low resolution, which can be improved by using kinematic Glogal Positionig System (GPS). It provides better means to improve the elevation data rapidly over large areas. It is possible to obtain accuracy up to a few millimeters in elevation.

The U.S. Department of Defense iniated the GPS with the goal to have a super precise form of worldwide positioning. They spend $12 Billion to build GPS network, a system that's changed navigation forever. The Global Positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations. GPS uses these man-made stars as reference points to calculate positions accurate to a matter of meters. In fact, with advanced forms of GPS one can make measurements to better than a centimeter. In a sense, it's like giving every square meter on the planet a unique address. GPS receivers have been miniaturized to just a few integrated circuits and so are becoming very economical. And that makes the technology accessible to virtually everyone. These days GPS is finding its way into cars, boats, planes, construction equipment, movie making, farm machinery, even laptop computers.

HOW GPS WORKS: GPS works in five logical steps:

1. The basis of GPS is triangulation from available satellites.
2. Along with distance, it is also necessary to know the position of satellites in space. Careful monitoring is done by ground control to acquire the accurate position of satellites.
3. The GPS does the triangulation from the distance and position of available satellites to get the latitude, longitude and elevation.
4. Finally the corrections for any delays of the signal experiences as it travels through the atmosphere.
5. For Kinematic GPS, one receiver is fixed at known benchmark and it takes continuous observations. The other receiver called rover is carried to the field to take observations

DESCRIPTION OF EQUIPMENT

a. GPS Receiver (4000 Ssi Geodetic Surveyor): The 4000 Geodetic Surveyor Ssi provides a highly productive and accurate solution for post-processed land surveying and mapping applications.

b. Antenna (Compact L1/L2): The Compact L1/L2 antenna is a versatile, high-performance, dual-frequency GPS antenna designed for tripod-mounted static survey and rangepole-mounted kinematic survey with Trimble GPS survey receivers

c. Software (GPS SURVEY): GPS Survey software is used for post-processing of the collected data from GPS. Post processing takes care of all types of corrections for every type of signal delay.

d. Technical Specifications: Technical specification is shown in Table 1.

Table 1: GPS modes and accuracy

Survey Type	Modes	Accuracy	Time
Static Survey	Quick-start Planned survey, Auto-timed survey and Fast Static survey	Horizontal 5mm + 1ppm (times baseline length), Vertical 10mm + 1ppm (times baseline length), Azimuth: 1 arc second + 5/baseline length in kilometers	Fast Static accuracy is a function of occupation time and observation conditions
Kinematic Survey	Continuous and Stop & go	2cm + 1ppm times baseline length (typical with L1/L2 kinematic antenna)	Continuous: 1 second Stop & go: 2 seconds (min)
Kinematic Survey	Real Time Kinematic Survey (RTK)	1.0m	

CATCHMENT DESCRIPTION:

The Chao Phraya river basin, located in between longitude 90^0E and $101^0 30'$E and latitude 15^0N to 20^0N, is the largest river basin in Thailand with a total drainage area of 178,000 km^2 (17.8 million ha) or one third of the country area (Figure 1). The headwater region of the basin is in the north in which the main tributaries of the Chao Phraya river originated namely: Ping, Wang, Yom and Nan. They merge to become the Chao Phraya River at Nakhon Sawan.

River Network: The DEM from global dataset GTOPO30 is used. The resolution of the DEM is 30 seconds, which is equal to 922 m in the study area. It was resampled to 1000 m and used to delineate the catchment boundary and to generate rivers using ARC/INFO. The generated river matches well in the Ping river basin, however, the matching is not good in the lower part of the Nan and Yom river basins, this is because, the lower part of the Nan basin is relatively flat area and generation of rivers are not good (Figure 2).

2. Use of GPS: Lower part of Ping and Yom rivers, which are flowing through flat area, were selected for modification of river system using the GPS. It was not possible to use the Kinematic GPS along the river, because there were no roads along the river. Fast static mode of GPS was used to collect the position and elevation at 5km to 10km intervals along the river depending upon the accessibility of the river to road.

Methodology to Improve Drainage Network

1. Elevation and position along the Ping and Yom rivers are calculated using the GPS post-processing software after collecting the data from GPS
2. Main river systems are digitized from a 1:250,000 scale map into the X and Y coordinates.
3. Observed points from GPS are selected from digitized points and calculated elevations are assigned to those points. Using the elevation of GPS points, elevation of other points are calculated by linear interpolation.
4. Position and elevations of all new points are input to the old DEM and new DEM is generated. Using the new DEM, river network and catchment boundary are generated and presented in Figure 3, which shows good agreement between the generated and the digitized river systems.

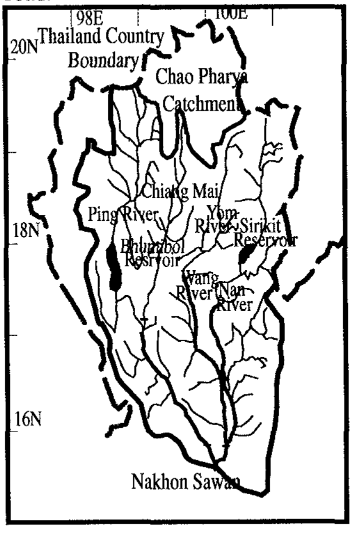

Figure 1: Location Map of Chao Phraya River basin

DISCUSSIONS

Recent advances in global positioning system, specially the kinematic GPS, provide means to improve the elevation data rapidly over large areas. It is possible to obtain accuracy upto a few millimeters in elevation using kinematic GPS and ideal for adding information in sparsely populated and poorly surveyed area. However, use of GPS alone in the filed surveys to obtain representative elevations has many practical problems. For modeling purposes, one needs the average elevation in the DEM grid scale. High accuracy of the GPS is not reflected in the measured values unless very dense measurements are taken, because the elevation can vary much within the required grid resolution. Trying to capture this micro variation can be a frustrating task, especially in vegetated areas, where one could very easily lose track of satellites and initialization has to be carried out all over again. On the other hand, river gradients can be very mild as in the case of middle and lower parts of a catchment, and hence high accuracy in elevation data along river network is needed. Therefore, it is logical to improve the DEM by measuring the river profiles and drainage lines rather than whole area of the catchment.

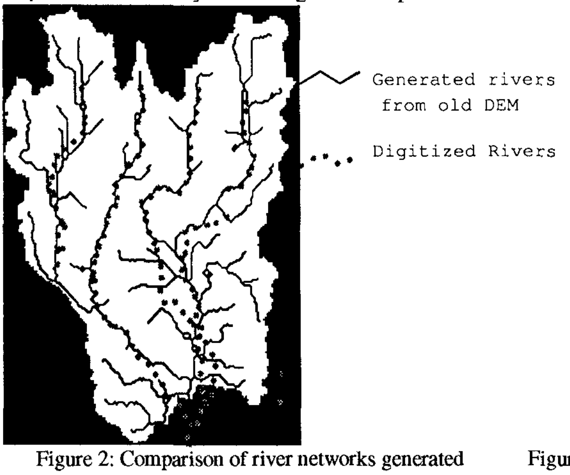

Figure 2: Comparison of river networks generated from original DEM and digitized rivers

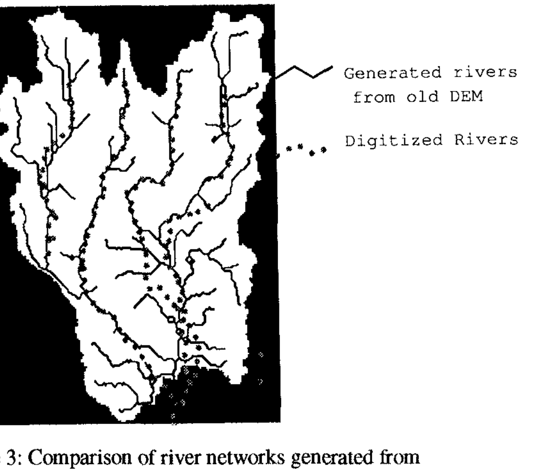

Figure 3: Comparison of river networks generated from improved DEM and digitized rivers