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FLOOD EXTENT IN THE LOWER MEKONG BASIN EVALUATED USING SPOT QUICKLOOK MOSAICS

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ABSTRACT: The Centre for Remote Imaging, Sensing and Processing (CRISP) in Singapore routinely receives and processes SPOT data acquired over Southeast Asia. For each scene received, CRISP generates a low-resolution "quicklook" image for cataloguing purposes. We have generated mosaics of these quicklook images to capture floods in the lower Mekong basin from 1997 to 2000. We find that these images are sufficient to provide a general picture of the effect of the floods. A comparison is made between the floods in different years and we generate a rough map of the flood extent for each year.

1. INTRODUCTION

The lower Mekong basin in Cambodia and Vietnam is often affected by floods during the wet season, which lasts from August to November, when the prevailing wind is the Southwest Monsoon. The flood usually peaks in October and recedes in December. The year 2000 saw an especially devastating flood affect the region. Flooding began one month earlier than usual, in mid-July, and a second wave of flooding reached disastrous proportions in September, and only slowly abated in October. It has been reported to be the most severe flood in 40 years, causing great economic damage, killing hundreds and affecting more than one and a half million people. (Volker et. al., 1993; Dutta and Takeuchi, 2000)

The Centre for Remote Imaging, Sensing and Processing (CRISP) in Singapore receives data from several SPOT (Satellite Pour l'Observation de la Terre) satellite passes daily. The images received consist of 3 bands in the VNIR (visible and near infra-red) region of the spectrum for SPOT 1 & 2, with an additional thermal infra-red band for SPOT 4. The coverage area includes part of South Asia and all of Southeast Asia. Following the successful acquisition of a particular pass, a low-resolution image of each scene captured (which covers about 60km by 60km) is generated for database and cataloguing purposes. These "quicklook" images are stored in JPEG format and are readily accessible via the catalogue on the CRISP website (http://www.crisp.nus.edu.sg).

We have found that mosaics assembled from these quicklook images are useful for obtaining a quick synoptic view of large-scale regions of interest, for example major floods or large forest fires. This method has previously been applied to estimate the area of burn scars of fires in Sumatra and Kalimantan (Liew et. al., 1998). We have generated a quicklook mosaic to record the 2000 flood the lower Mekong basin, and at the same time, we have also assembled wet season mosaics of the same region for the years 1997–1999 as comparison. A dry season mosaic was also generated as a control.

2. METHOD

Based on the region and time period of interest, we first collect a list of SPOT quicklook scenes in our archive, giving preference to those which have less cloud cover and which are closer in time and space to our intended area of focus. Southeast Asia is a region which has a considerable amount of cloud cover throughout the year, and thus it may be necessary to sift through multiple images of the same location to obtain images which are least obscured.

After obtaining a list of desired scenes to form the mosaic, the individual JPEG quicklook scenes are then converted to TIFF images. The CRISP catalogue provides latitude and longitude information for the four corners and the centre of each quicklook image. Utilising this information, we are able to perform a 1st-order polynomial transformation to correct for geometric distortion and register the quicklook scene onto the final mosaic image. The pixel separation of

Figure 1: 2000 flood mosaic. The strips on the right were composed from SPOT 4 scenes (R: band 4, G: band 3, B: band 2) while the strips on the left were composed from SPOT 1 and SPOT 2 scenes (R: band 4, G: band 3, B: band 2).

the final image is approximately 120m, with relative registration between adjoining quicklook scenes accurate to one pixel or less.

To estimate the areal extent of the flood, we delineate the boundary of the flood region by visual inspection. The resulting image of the delineated region is then converted to a Lambert Azimuthal Equal Area projection before we sum up the enclosed area to arrive at the areal estimate of the flood extent.

3. RESULTS

3.1. Mosaics

The year 2000 flood mosaic (Fig. 1) of the lower Mekong Basin was prepared from SPOT scenes captured throughout September 2000, with two early October images to fill up the remaining gaps. The least cloudy images were chosen. The flood boundaries in different parts of the mosaic are therefore not of the same day but the mosaic does illustrate and record the wide extent of this extraordinary flood. SPOT 1 and 2 scenes show vegetation in red, while in SPOT 4

Figure 2: 1999 flood mosaic

Figure 3: 1998 flood mosaic

Figure 4: 1997 flood mosaic

Figure 5: Dry season mosaic (2000)

scenes, vegetation appears green. Even though the mosaic is assembled from these two types of images, the flood-affected region is still clearly seen; the bluish or dark areas in the mosaic represent the inundated area.

For the years 1997–1999 (Figs. 2–4), we endeavoured, as far as possible, to compile the flood mosaics from only September and early October scenes. However, as there was less SPOT coverage (the CRISP catalogue for SPOT 4 data begins only in the last two months of 1999) before 2000, there were a few gaps in the mosaics which we had to fill in using August and November scenes. This spread in the time distribution of the individual scenes has to be taken into account when interpreting the mosaics. Nonetheless, its effect should not be serious enough to affect our purpose of estimating the flood area. Finally, a mosaic was also compiled from scenes captured during the dry season of 2000 (from January to March) as an indication of the unflooded appearance of the region (Fig. 5).

Comparing with the flood mosaics of the region in past years, it is apparent that the 2000 flood is the most serious in the past few years. The uniformity and smoothness of the bluish flood region gives one the impression of a large lake in the area. The flood mosaics of the previous years on the other hand show the corresponding region as a water-logged but not contiguously water-covered area. In fact, flooding is barely discernible for the year 1998, as can be seen when comparing it with the dry season mosaic.

3.2. Flood extent

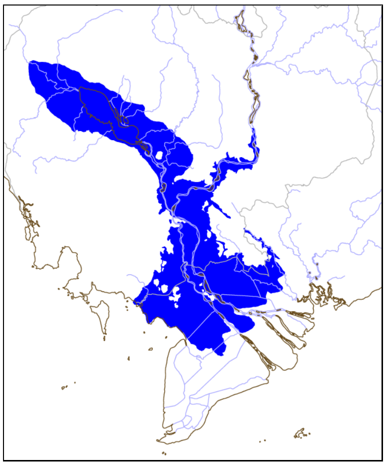

Figure 6: 2000 flood extent

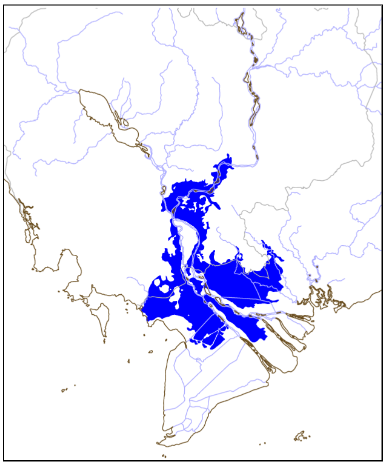

Figure 7: 1999 flood extent

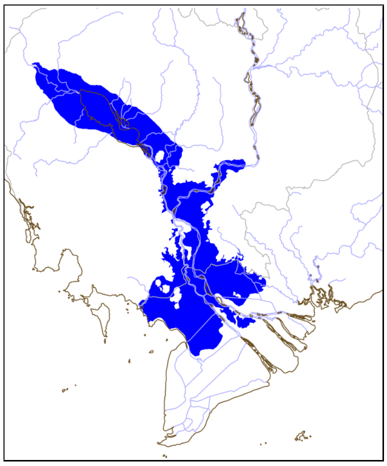

Figure 8: 1997 flood extent

Year	Highlighted Area	Area (excluding max. Tônlé Sap Area)
2000	43,800 km^2	33,300 km^2
1999	20,400 km^2	20,400 km^2
1997	33,100 km^2	22,800 km^2

Table 1: Estimated flood area for different years

The area affected by the floods was estimated by highlighting the flood region in blue (Figs. 6–8) and computing the covered area as described in Section 3. We have omitted 1998 because the flood region is not clearly discernible for that year. Note that the annual flooding of the Tônlé Sap lake does not show up clearly in the 1999 mosaic (Fig. 2) and thus it was not included in the flood extent delineation. For a better comparison between the 3 years shown, we subtract the wet season maximum area (Source: Dutta and Takeuchi, 2000) of Tônlé Sap from the 2000 and 1997 flood areas. The resulting affected area in 2000 is still about one and half times larger than in the other two years. It should be mentioned here that the subjectivity of the delineation criteria and the temporal spread of the constituent scenes (especially of the earlier years) will lead to a degree of error in the calculated area. Therefore the figures listed in Table 1 are accurate to at most two or three significant figures; as an estimate this is nonetheless sufficient.

A further point to note is that the actual severity of the 2000 floods is even greater than the above numbers indicate. In previous years' mosaics, there are probably many patches of unflooded land amid the flood waters, causing the flooded area in the mosaics to appear less smooth. In contrast, the intensity of the blue-coloured flood region in the 2000 mosaic suggests that the original landscape features are even more completely submerged. This is reflected in reports of flood waters reaching record levels in that year (Dutta and Takeuchi, 2000).

4. CONCLUSION

In summary, we have presented a quick method for compiling a mosaic from SPOT data, and which was used to obtain a rough estimate of the extent of a major flood. This kind of flood area estimation may otherwise be difficult to carry out on the ground or from the air, due to the large area affected. Our results also highlight the extraordinary severity of the 2000 floods in the lower Mekong basin.

The flood mosaics are generated from JPEG compressed reduced resolution SPOT quicklook images. Due to the lossy nature of JPEG compression, data integrity is not preserved. It is therefore not suitable for use in subsequent numerical analysis based on spectral band values. However it is still acceptable for a visual overview of the region of interest. In any case our interest here is in presenting a method which is economical in terms of time taken and hard disk storage space needed; a more in-depth study will necessarily require processing of the full-resolution scenes.

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