Mekong River Commission Secretariat

Flood situation report August, 2008

MRC Technical Paper
No. 21

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Meeting the Needs, Keeping the Balance

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Contents

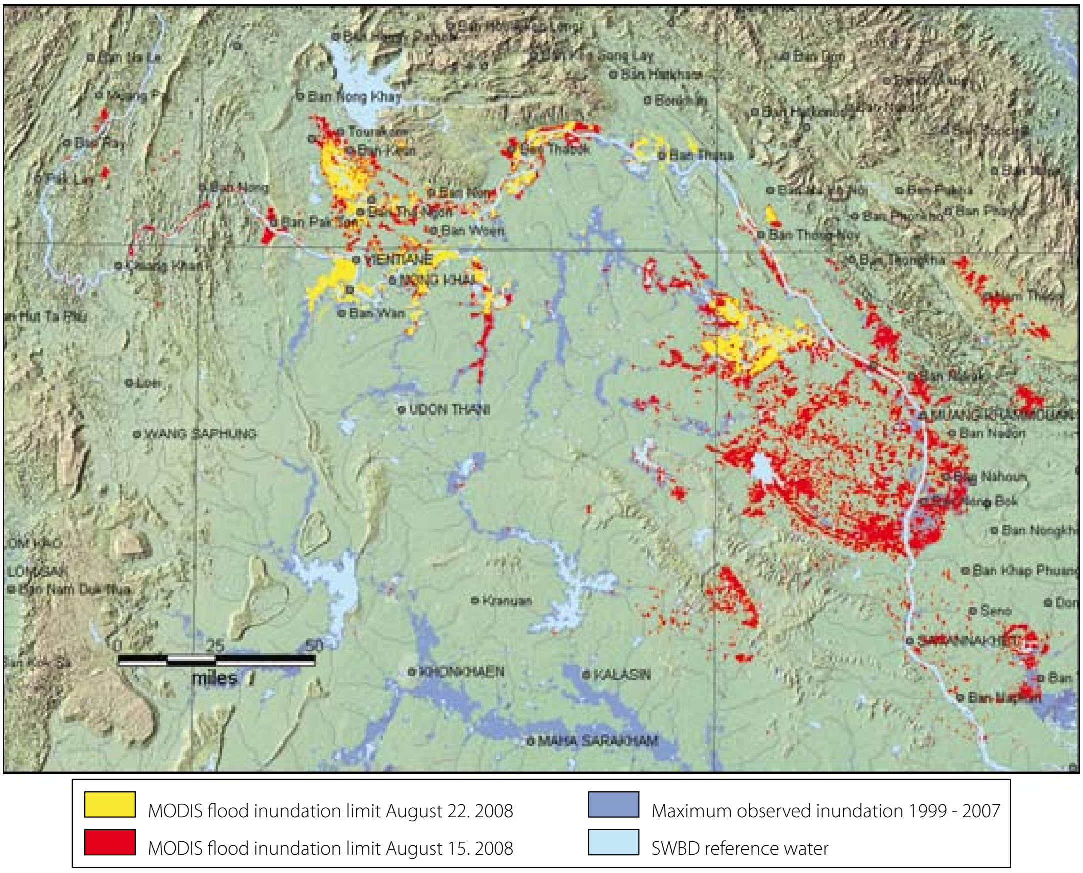


Figure 1. Flood extent maps in the Vientiane to Savannaketh reach for 15th and 22nd August 2008. (Source: G. Robert Brakenridge, Dartmouth Flood Observatory, Dartmouth College, USA.)

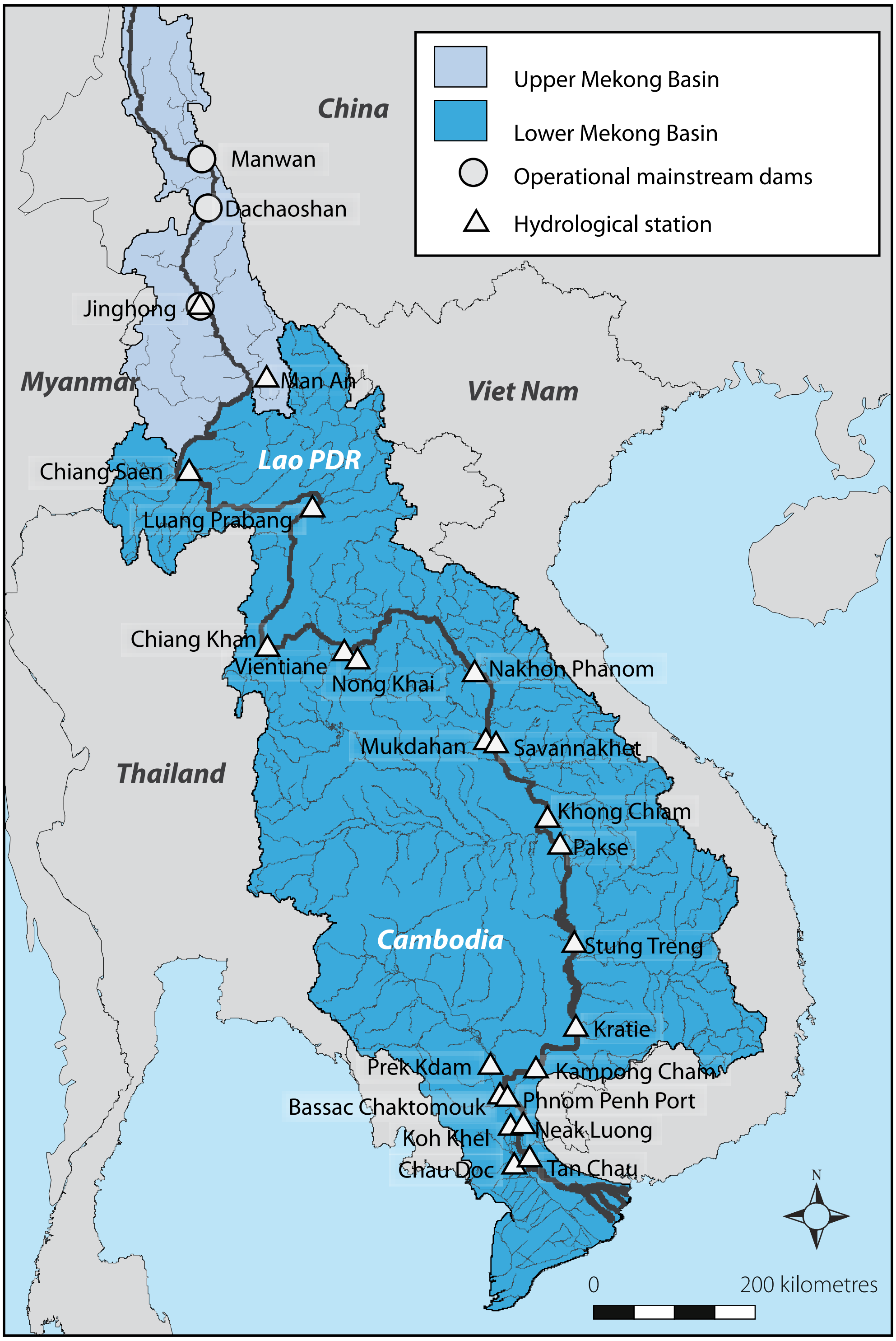


Figure 2. Locations referred to in the text.

1. Summary

During the second week of August 2008, flood water levels in the Mekong Basin reached extreme levels, particularly at Luang Prabang, Vientiane and Nong Khai. The flood resulted from tropical storm Kammuri that tracked westwards across northern Lao PDR and southern Yunnan on the 8th, 9th and 10th of the month. Generally this produced 100 – 150 mm of rainfall, though locally figures were as high as 250 mm. Catchments were already saturated as a result of strong monsoonal conditions during May, June, and July, with the consequence that flood runoff was maximised.

Flood water levels at Chiang Saen and Luang Prabang were such that large areas were inundated, and it was only as a result of effective action by the authorities that the city centres of Vientiane and Nong Khai were generally protected from inundation. Although water levels at Vientiane (specifically at the stream gauge at Kilometre 4) were 1 m higher than in 1966, when the city centre was flooded, the peak discharges were of the same order. These higher water levels for similar discharge conditions are explained by the raising of flood protection levees on both banks of the river after the 1966 event, and the resulting containment of the flood flow within the channel.

At most locations along the mainstream, levels reached at least the alarm stage, and in the Delta water levels remained above the alarm stage on 2nd September[1]. The flood runoff was almost entirely generated in the area between Jinghong and Luang Prabang, and as a result the most critical flood conditions occurred in the upstream reaches. Nevertheless, the continuing strong SW Monsoon and significantly above-average seasonal rainfalls resulted in water levels remaining very high in the middle reaches of the basin. With at least six to eight weeks of the flood season remaining, and the peak of the cyclone season still to come, the flood situation remains critical. Though water levels have decreased somewhat, continuing storms have not seen them decrease to levels that provide acceptable factors of safety. The region remains highly vulnerable to the impacts of additional tropical storms tracking across the basin during the remainder of the season.

Analysis of the available storage behind the three dams currently operational on the Mekong mainstream in Yunnan reveals this to be insignificant compared to the volumes of runoff that occurred during the course of the flood. Any releases from these dams would have played no role in the conditions that developed, which were the result of natural meteorological and hydrological circumstances.

The August 2008 event was the first regional flood episode for which the RFMMC provided forecasting services, on the whole results were encouraging. However, lessons to be learnt include:

1 Alarm levels are always reached at Chao Doc and Tan Chao.

- Forecast rainfall data and resulting predicted tributary runoff tend to cause substantial oscillations in the forecasted water levels from day to day. 'Learning algorithms' incorporated within the model could refine and dampen flood forecasts as the event evolves.

- The performance of the forecasting underscored data deficiencies and the poor understanding of the flood hydrology of the major tributaries in the Lao PDR north of Luang Prabang. Here, calibration of the hydrological component of the overall model needs to be addressed.

- However, even given these limitations regarding the data, the forecast given on 10th August for Vientiane correctly indicated that the flood level would be exceeded. Furthermore, the maximum flood level in Vientiane was forecast on the 13th August to within 20 cm of that actually observed two days later on the 15th.

- Hydrometric data supplied by China under the agreement with the MRC proved to be extremely important, as it provides a solid starting point for the flood routing on the mainstream. However, this information is not yet used to its full potential. Respective parts of the forecasting model require review and improvement.

- At least three-hourly updates of water levels from the AHNIP (Appropriate Hydrological Improvement Project) and HYCOS (Hydrological Cycle Observation System) stations are required. Data loggers can be placed in an automatic one- to three-hourly automatic transmission mode during the critical flood season.

- Following the event a systematic review of the performance of the flood forecasting technology in the Mekong Basin, both hydrologically and statistically, will be conducted.

- In the short term, institutional arrangements to disseminate MRC forecasts and early warning need to be reviewed, in terms of their usefulness for counterpart agencies, their distribution channels and comprehensive coverage of recipients.

2. Meteorological conditions

Tropical storm Kammuri struck southern China on the 6th August and moved west into northern Viet Nam and on into northern Lao PDR and southern Yunnan over the following days (Figure 3).

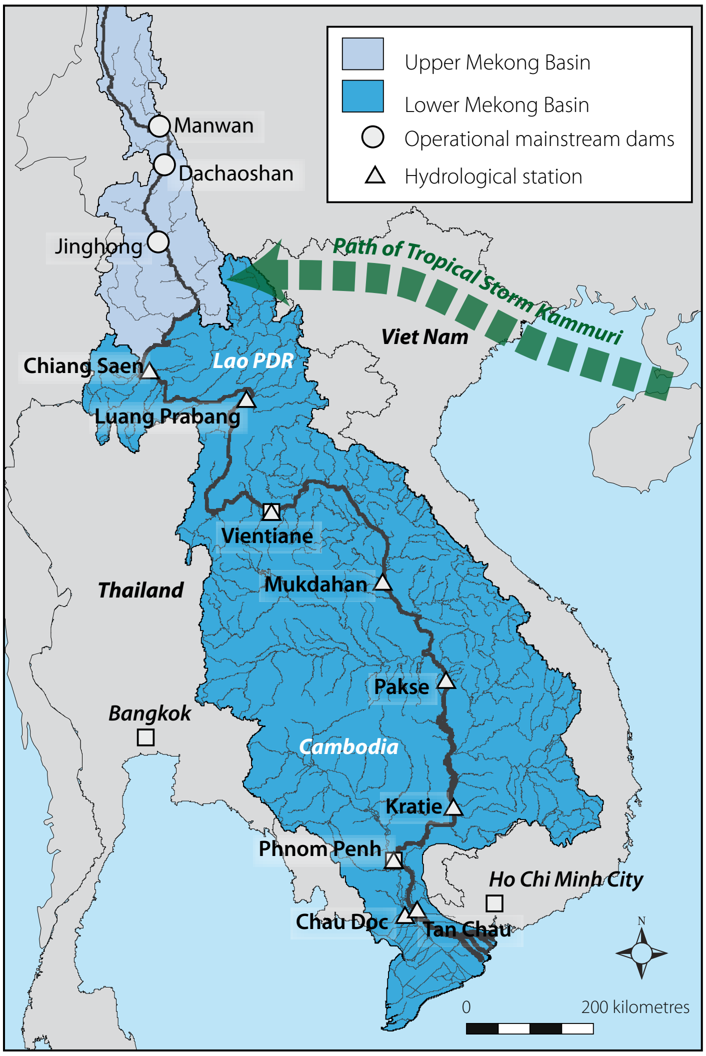


Figure 3. Track of tropical storm Kammuri — first week of August, 2008. (Map based upon data obtained from the Hong Kong Meteorological Bureau http://weather.gov.hk)

As it moved into the Mekong Basin, the major areas of associated storm rainfall lay in northern Lao PDR and southern Yunnan (Figure 4):

- In the Lao PDR most rainfall occurred upstream of Luang Prabang. Accumulated rainfall over the nine days between the 6th and 14th August was generally between 100 and 150 mm, though locally these recorded figures were as high as 200 – 250 mm.

- In Yunnan the cumulative rainfall was similar and generally confined to the extreme south, downstream of Jinghong.

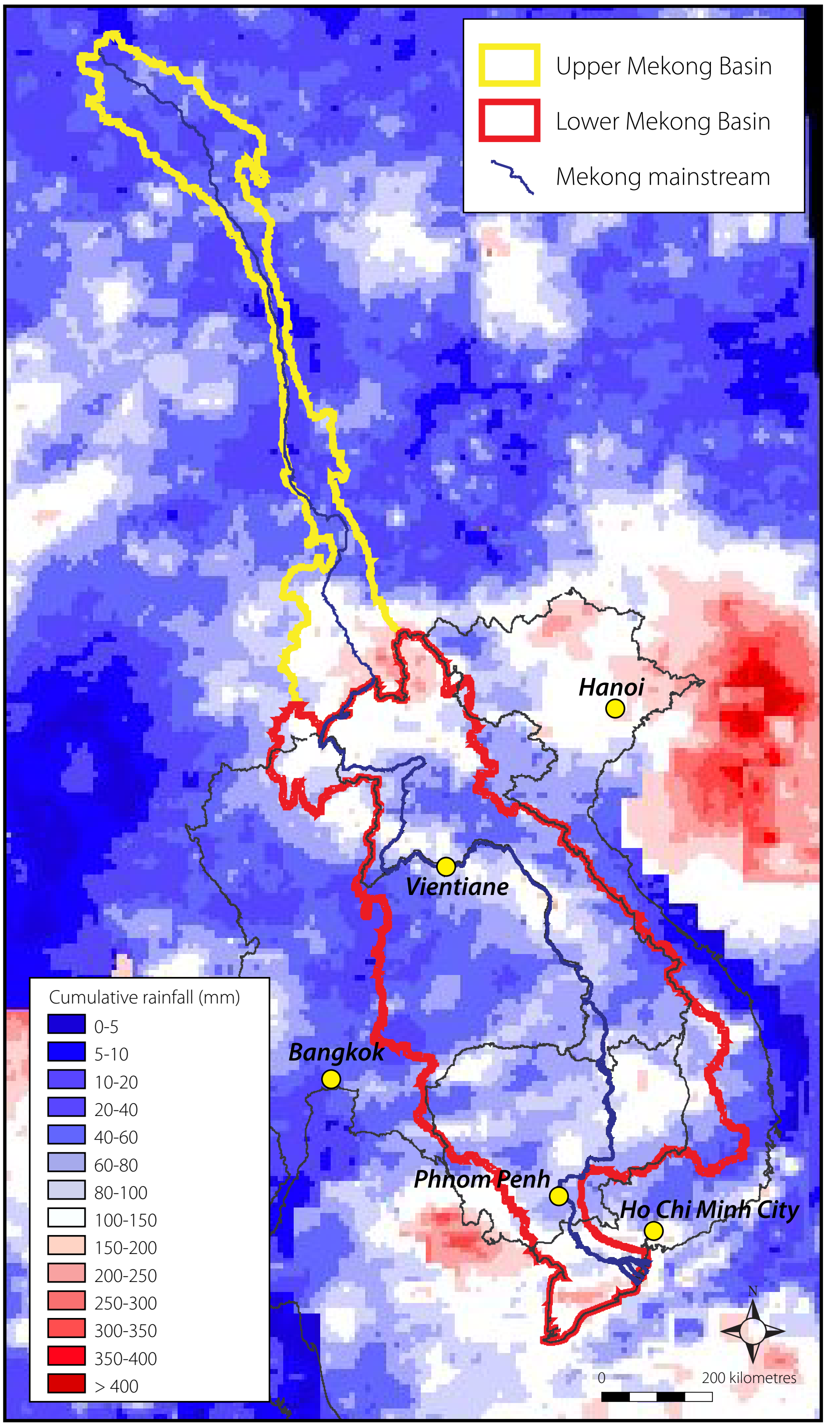


Figure 4. Accumulated rainfall over the Mekong Region: 6th – 14th August 2008 (based on data provided on a daily basis by the United States National Oceanic and Atmospheric Administration to the MRC).

These areas therefore generated virtually all of the consequent flood runoff. Elsewhere in the lower basin the rainfall was much more scattered and not directly linked to Kammuri. However, some central and southern areas did receive up to 150 mm over the same period. The 2008 monsoon has so far produced considerable amounts of rainfall over the basin as a whole since its onset in early May. These conditions have led to saturated catchments throughout the basin (Figure 5) and therefore flood runoff from tropical storms such as Kammuri was at a maximum.

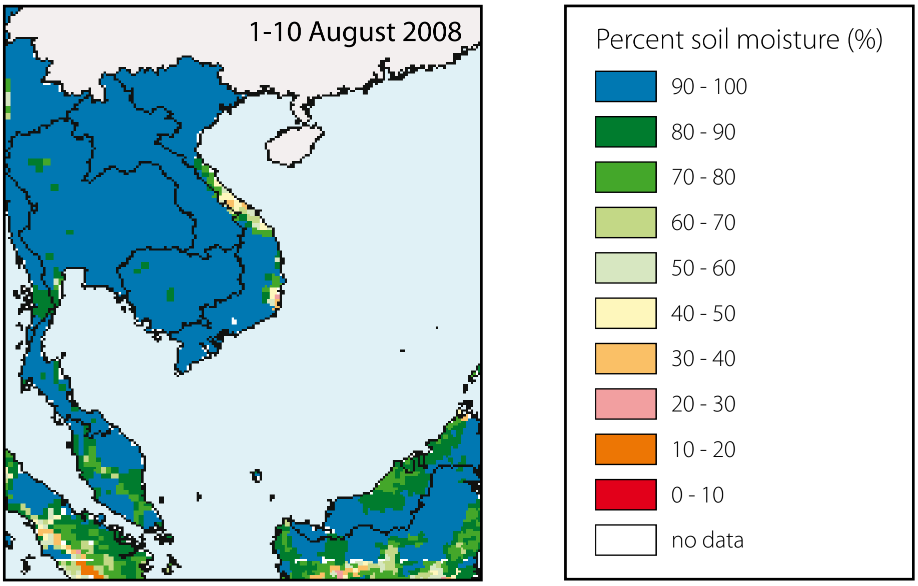


Figure 5. Regional soil moisture conditions during early August 2008, indicating that catchments were saturated. This would have maximised the flood runoff that resulted from tropical storm Kammuri. (Source: USDA, http://gcmd.nasa.gov/records/GCMD_USDA_FAS_Percent_Soil_Moisture.html.)

This year, 2008, is a strong La Niña year, during which there is the probability of a more intense SW Monsoon over SE Asia. The above-average regional rainfall thus far in 2008 tends to confirm this link. La Niña conditions are also associated with a higher frequency of tropical storm formation in the Western Pacific.

3. Water levels

The water level at reached Vientiane on the 15th of August was the highest recorded since records began in 1913. At 13.7 m above the gauge datum, it was 1 m more than the maximum levels achieved in 1966, 1971 and 2002 (Table 1).

Table 1. *Comparative maximum historical flood water levels at Chiang Saen, Vientiane and Mukdahan.*

Year	Maximum water level achieved above gauge datum (m)		
	Chiang Saen	Vientiane[2]	Mukdahan
1924	No data	12.7	No data
1929	..	12.4	..
1942	..	12.2	..
1966	**13.8**	12.7	**13.6**
1970	9.8	12.2	13.2
1971	11.0	12.5	12.5
2002	10.4	12.6	12.3
2008	10.6	**13.7**	12.7

[2] Levels recorded at the river gauge at Kilometre 4.

Upstream at Chiang Saen and downstream at Mukdahan, the August 2008 maximum water levels were lower than those experienced in 1966, being over 3 m lower at Chiang Saen. This reveals that the situation in 1966 was somewhat different to that in 2008. In September 1966 tropical storm Phyllis tracked further north than did Kammuri in 2008. So while most of the floodwater in 1966 originated in Yunnan, in 2008, the origin of the floodwater was more or less evenly split between China below Jinghong and the large left-bank tributaries in northern Lao PDR.

It is worth noting that the rapid water level rise at Luang Prabang occurred one day before water levels rose at Man An tributary station in China. This also strongly suggests that the flood event was primarily caused by heavy rainfall in the basins of the Mekong tributaries in the north of the Lao PDR.

At Mukdahan, the 2008 water levels were lower than in 1966 and 1970, indicating a modest contribution from the central Lao tributaries and some attenuation of the August peak downstream of Vientiane.

Water levels within the Cambodian floodplain and the Delta continued to increase and on the 25th August were 0.47 m above the alarm stage at Tan Chau and 0.26 m above it at Chau Doc.[1]

4. Flood discharges

The relationship between maximum water level and discharge achieved at Vientiane on the 15th August is revealing when compared to those of 1966. Although the water level reached in 2008 was 1m higher than that of 1966, the discharge was slightly less. In 1966 peak flood discharge was 26,000 cumecs, while that in 2008 was 23,500 cumecs. The explanation may lie with the

1 Alarm levels for Tan Chao and Chao Doc are always reached during the flood season.

flood protection works that were undertaken after 1966 on both the Thai and Lao banks of the river, subsequent to the inundation of Vientiane, Si Chiang Mai and Nong Khai. These works involved raising flood protection levees that contain the river within its channel up to 14 m above the gauge datum. This may explain why for a given discharge, water levels are now higher while the river did not overtop the embankment as it did in 1966.

At Chiang Saen the maximum discharge reached on the 12th August was 13,300 cumecs, which has only been exceeded three times (in 1966, 1970 and 1971) since records began in 1960.

Further downstream at Pakse and Kratie the peak discharges observed so far in 2008 have been average. This confirms the fact that peak inflows from the large left-bank tributaries in the Lao PDR downstream of Vientiane were not excessive, and that the Mekong flood of August 2008 was very much the result of meteorological and hydrological conditions in the northern regions of the basin, upstream of Vientiane.

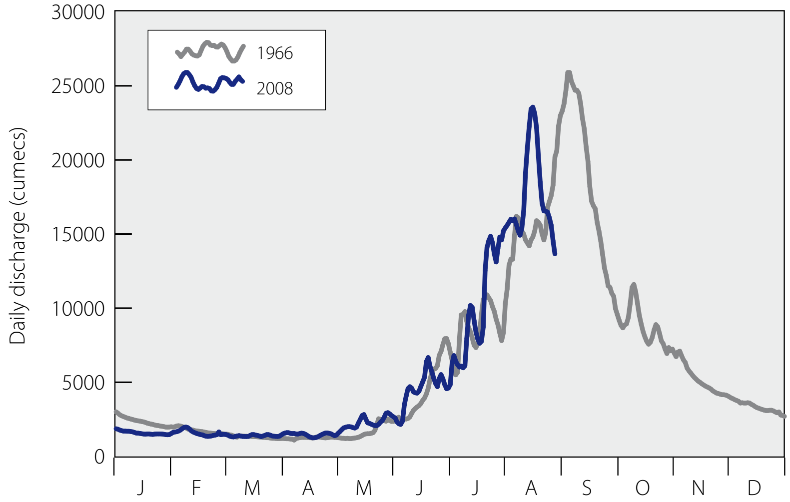


Figure 6. Comparative discharge hydrographs for the Vientiane – Nong Khai reach of the Mekong, for 1966 and 2008.

5. Flood volumes

Although the peak discharges downstream of Vientiane have so far in 2008 been average, the flood volumes were, and remain, considerably above normal. This situation indicates that flood runoff remains high, though to date there have been no individual storm events in the central and southern areas of the basin that have generated excessive peak discharges. The importance of assessing the flood volumes is that they are the best indicator of the potential duration of inundation and the severity of flooding in the Cambodian floodplain and the Delta. In 2008 the flood season in the Lower Mekong Basin began during the first week of July, which is the expected time of onset.[1]

- At Chiang Saen the volume of floodwater over the flood season from then to the 19th of August was 29 km^3, which is average and indicates that flows out of China were relatively low until the commencement of the August flood event.

- At Vientiane the equivalent figure is 64 km^3, which is virtually the same as those during the recent flood years of 2000 and 2001 in the Cambodian floodplain and the Delta. This figure is much higher figure than that at Chiang Saen and indicates substantial early season flood runoff from the left bank tributaries in northern Lao PDR. A volumetric comparison with conditions in 1966 is not possible as that event did not occur until later in the flood season, in the first week of September.

- By the 25th of August the total flood volume at Pakse and Kratie had tailed off to figures significantly below those of 2000 and 2001.

- At Kratie the figure on the 25th of August was 150 km^3, compared to 290 km^3 in 2000 and 260 km^3 in 2001. These figures confirm that flood runoff from the large tributaries downstream of Vientiane has, so far in 2008, been modest and representative of that in an average year.

Nonetheless water levels in the Cambodian floodplain and the Delta, specifically at Chau Doc and Tan Chau, are such that the area remains vulnerable to flooding given the oncoming peak of the cyclone season.

6. The role of the mainstream dams in China on the events of August 2008

The potential role of the three existing mainstream reservoir storages in Yunnan on the volume and peak discharge of major floods in the northern areas of the Lower Mekong Basin is insignificant. In other words, they do not have the capacity to materially modify natural flood conditions.

Their combined active storage is less than 1 km^3 (Table 2) and only a small portion of this could be released practically. The effective drawdown releases would be very small compared to the volumes of mainstream flood flow, and would be controlled by those from Jinghong, the downstream dam in the cascade. The rates of release would also be minor compared to the peak flood discharges.

1 The flood season is defined as the period of the year in which flows exceed the long-term mean annual discharge. This definition permits the timing of the onset and end of the flood season to be compared from year to year.

Table 2. *Active and gross storage volumes of the Mekong mainstream dams in Yunnan. (Source: http://adb.org/Documents/Studies/Cumulative-Impact-Analysis/A3-Reservoir-Hydropower-Data.pdf)*

Dam	Gross Storage km^3	Active Storage km^3
Manwan	0.92	0.25
Dachaoshan	0.96	0.37
Jinghong	1.04	0.25
Total	2.92	0.87

In relation to the volumes of flood water that actually occurred during August 2008, any releases from the reservoirs could not have been a significant factor in this natural flood event. At Chiang Saen the flood peaked on the 12th, by which time the accumulated flood runoff for the month had reached 8.5 km^3, an order of magnitude greater than anything that could be realistically released through reservoir drawdown. At Vientiane the flood peaked several days later on the 15th, by which time the accumulated flood volume there from the beginning of the month had reached 23 km^3.

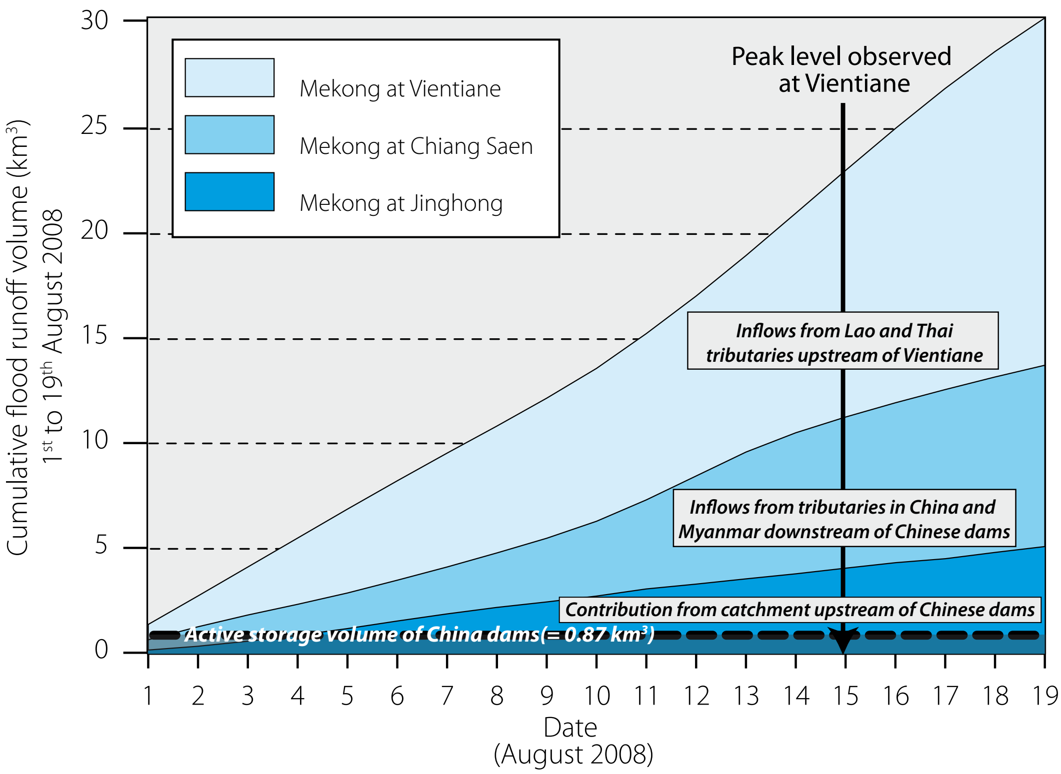


Figure 7. Cumulative Mekong flood runoff volume (km^3) between the 1st and 19th of August, 2008 at Chiang Saen and Vientiane, compared to the combined active storage of Manwan, Dachaoshan and Jinghong reservoirs on the mainstream in Yunnan.

The flood was the result of natural meteorological and hydrological processes, with approximately 50% of the overall volumes of floodwater entering the lower basin as flood runoff from Yunnan (Figure 7). The rest of the floodwater that reached Vientiane and Nong Khai was mainly contributed by the large left-bank tributaries in northern Lao PDR, such as the Nam Tha, Nam Ou and Nam Khan.

7. Risk of occurrence

The statistical analysis of water levels to determine the annual risk of flood occurrence is constrained by the fact that flood protection works have influenced historical levels, and therefore do not a represent a consistent statistical sample. In terms of discharge, the flood of August 2008 is estimated to have the following risk of occurrence:

Table 3. *Estimated annual recurrence interval of the maximum discharge of August 2008 (MRCS).*

Station	Peak discharge (cumecs)	Annual recurrence interval
Chiang Saen	13,300	1:5 years
Luang Prabang	23,100	1:30 years
Vientiane/Nong Khai	23,500	1:25 years
Pakse	35,000	1:2 years
Kratie	40,000	1:2 years

These figures confirm that the combination of the flood runoff from China with that from the tributaries upstream of Luang Prabang, combined to produce a relatively extreme peak discharge at Luang Prabang and at Vientiane. The peak discharge at Chiang Saen indicates that the peak discharge from China was not significantly above average, while those downstream of Vientiane were average due to the fact that flood runoff from the large tributaries in the central and southern areas of the basin were not affected by tropical storm Kammuri.

8. Prospects for the rest of the 2008 flood season

Since basin-wide water levels remain high, rainfall conditions remain above normal, and the peak of the cyclone and tropical storm season will not arrive until September and October, the prospect of the onset of potential further critical flood conditions remains significant. Regionally, tropical storm development is active.

Two intense systems were identified on the 27th August (Figure 8) to the NW and SE of the Philippines. These were forecast to move north west and make landfall over southern China, and significantly affected Hong Kong.

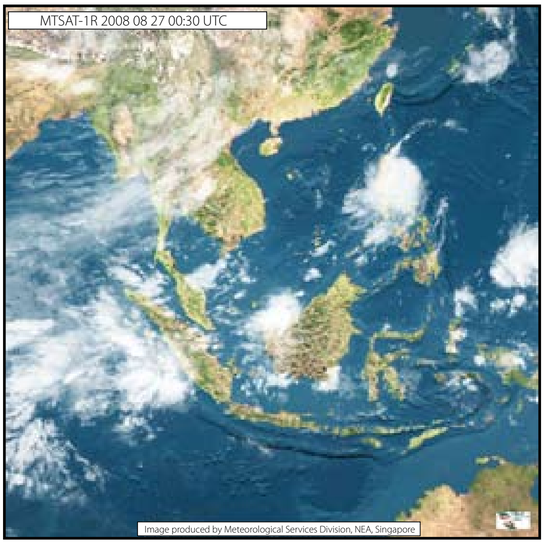


Figure 8. Tropical storm activity over the Western Pacific on the 27th of August 2008.
(Source. Singapore Weather Information Portal www.weathe.gov.sg/wip/web/ASMC/Satellite- imagary/Southeast_Asia /MTSAT-1r)

The development of further tropical storms is inevitable as the season progresses. The peak seasonal incidence of tropical storms in the south of Viet Nam occurs in October (Figure 9).

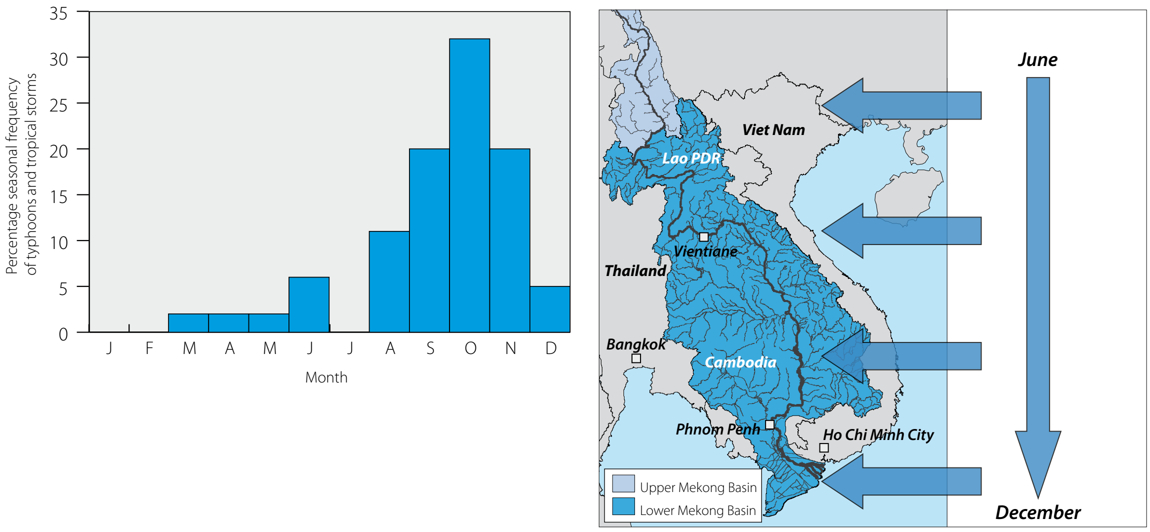


Figure 9. The seasonal percentage frequency and average seasonal tracks of typhoons and tropical storms.
As the season progresses the storm systems moving westwards from the South China Sea tend to make landfall progressively further south along the coast of Viet Nam (based on data in Giang, L.T., 2005.)

As the season progresses their path westwards from the South China Sea and the Gulf of Tonkin tends to move from north to south, though there are common exceptions to this general pattern, as Kammuri proved. The average annual number of such events is five, though the number can be as high as eighteen, as in 1964. The basin, particularly towards the south, therefore remains vulnerable to the incursion of further storm systems, all the more so if water levels remain as they currently are.

Although the flood levels at Vientiane and Nong Khai have fallen, history suggests that there remains a significant probability that they will increase again before the end of the flood season. By way of example, in Figure 10 water level trajectories are set out for the Vientinae–Nong Khai reach from the 19th August onwards for those years prior to 2008, during which water levels in mid-August stood at 11 m or more above the gauge datum. Although water levels can fall by as much as three metres by late August–early September, history indicates that in many years levels rise once again close to or in excess of the August flood level, and that these conditions can occur as late as the last week of September.

Flood plain storage and the water levels of the Great Lake are slightly above average and rising in response to the arrival of the floodwater from upstream (Figure 11). Since September and October are likely to see the occurrence of tropical storms in these southern areas of the basin, vigilance needs to be maintained. This vigilance is particularly important with regard to tropical storm development in the Western Pacific, which, as Figure 6 shows, remains active.

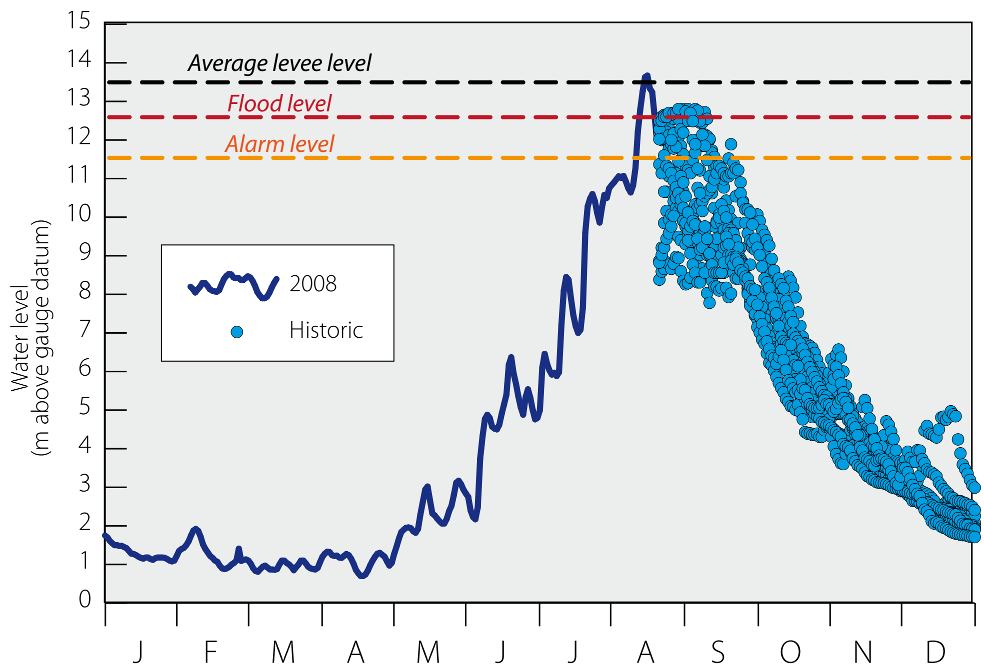


Figure 10. Mekong at the Vientiane–Nong Khai reach.
Daily water level trajectories from the 19th August onwards for those years prior to 2008 during which water levels in mid August were > 11 m above the gauge datum.

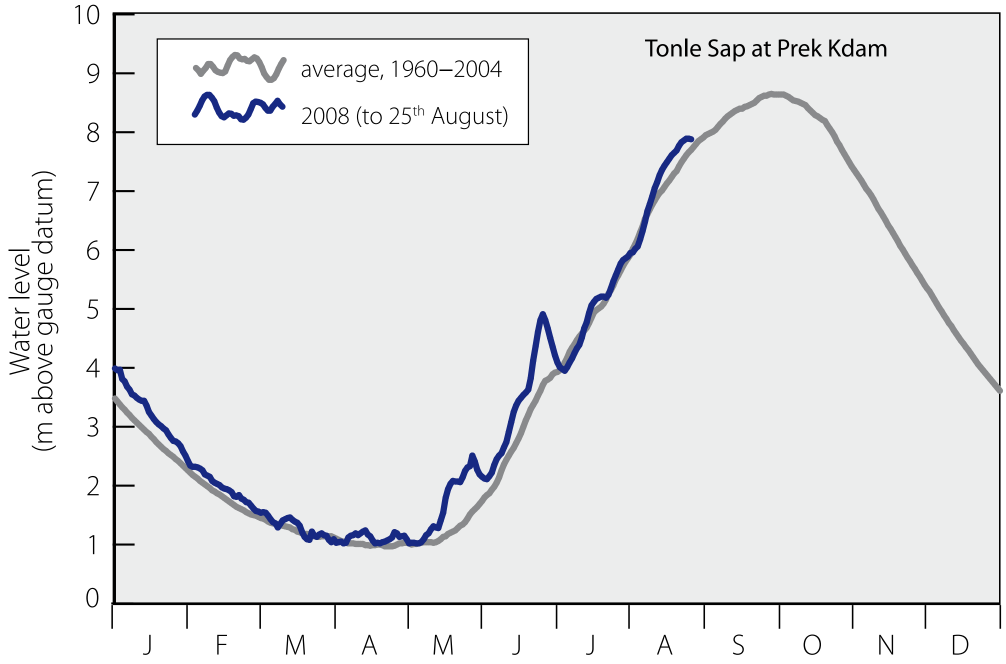


Figure 11. Water levels in the Tonle Sap system in 2008 compared to their long term average.

9. Damage

It is very early to assess the damage caused by the event, but already the scale of losses is apparent. Comprehensive damage assessments are being carried out, but preliminary accounts indicate that the major impact of tropical storm Kammuri occurred in the northern provinces of Viet Nam. News reports suggest that 120 people died and that 20,000 houses were damaged or destroyed by floods, landslides and high winds.

According to the Interior Ministry in Thailand (reported by Reuters on the 18th August), the flood was the worst in 100 years, claiming six lives, and causing damage estimated at 223 million baht (US$66.5 million) thus far in the country. Initial estimates suggest 92,000 households and 200,000 ha of agricultural land were directly affected.

In Lao PDR, on the 22nd of August the *Vientiane Times* published initial damage assessment. The paper reports that damage in Luang Prabang province alone could be as high as 100 billion kip (US$12 million). Reported losses in Vientiane province are close to 148 billion kip (US$17.5 million). Six deaths have since been reported. In Khammuan province alone, the flood damage is initially assessed to be at least 31 billion kip (US$3.6 million). The floods destroyed rice fields, irrigation systems, roads, and schools in the province. Almost 6,000 hectares of rice fields were damaged along with 167 hectares of other crops, 48 irrigation systems, and 41 schools. In Borikhamxay province authorities estimate damage to the agriculture sector is worth at least 90 billion kip (US$ 10 million). Road Number 13 South was damaged, as were unpaved roads which had linked villages. It should be stressed that these are preliminary assessments and the responsible authorities will release more detailed reports in due course.

Figure 12. Flooding in Ban Kao Liao, Vientiane, 13th August 2008.

10. Performance of the RFMMC flood forecasting

The flood of August 2008 was centred within the upstream regions of the lower basin, with significant further contributions of flood water from the far south of Yunnan. The major scrutiny of the performance of the flood forecasting technology therefore lies with its ability to predict water levels to an acceptable degree of accuracy in these areas of primary impact, and the subsequent consequences further south as the floodwater moved downstream. The outputs required are:

- The timing of water level increases and decreases and the potential duration of critical periods above flood and warning levels, and;

- The water levels that are estimated to occur over time.

These temporal and quantitative aspects are combined by attempting to forecast the levels over one to five day lead times using information on storm rainfall and catchment condition, and then routing the estimated flood runoff downstream. Obviously, as lead time increases accuracy reduces. Figure 13 shows the forecast accuracy of the predicted levels between Chiang Saen and Chau Doc as the mean absolute error in metres between observed and predicted water levels, over the period 19th July – 22nd August 2008.

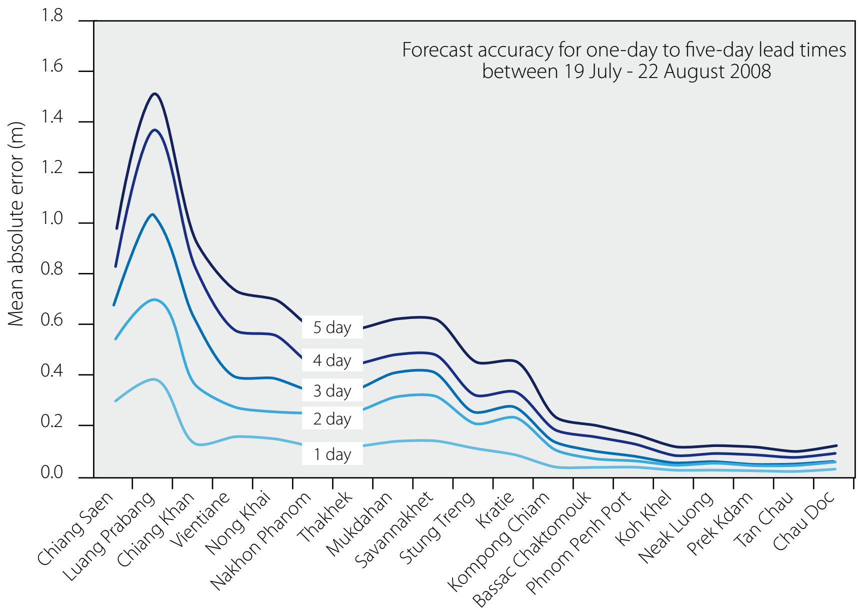


Figure 13. Forecast accuracy of the predicted levels between Chiang Saen and Chau Doc over the period 19th July – 22nd August, 2008.

The general picture that emerges is of significant more accurate forecasting for stations downstream of Kompong Cham. This coincides with the fact that upstream of this station, the errors and unknowns associated with the contributions of flood water to the mainstream from the large left bank tributaries in the Lao PDR reduce accuracy. Downstream the tributary contributions are small, so that prediction is almost entirely based on flood routing and therefore much more precise.

Reduced accuracy is observed at the stations upstream of Vientiane and Nong Khai. This is exclusively the result of limited data on the mainstream contributions of the major tributaries in this reach, principally the Nam Ou, Nam Khan and Nam Tha. Rainfall data are particularly deficient, with the exception of those for the right bank Thai tributaries, though in the main these are smaller.

It is also evident that the current information received from China allows a one day forecast at Chiang Saen of flood levels within an order of +/- 0.30 m, and a five-day forecast within an order of +/- 1 m.

The performance of the flood forecasts increased significantly between the 10th and 13th of August, with the peak water level at Vientiane predicted to within 20 cm over a lead time of two days (Figure 14).

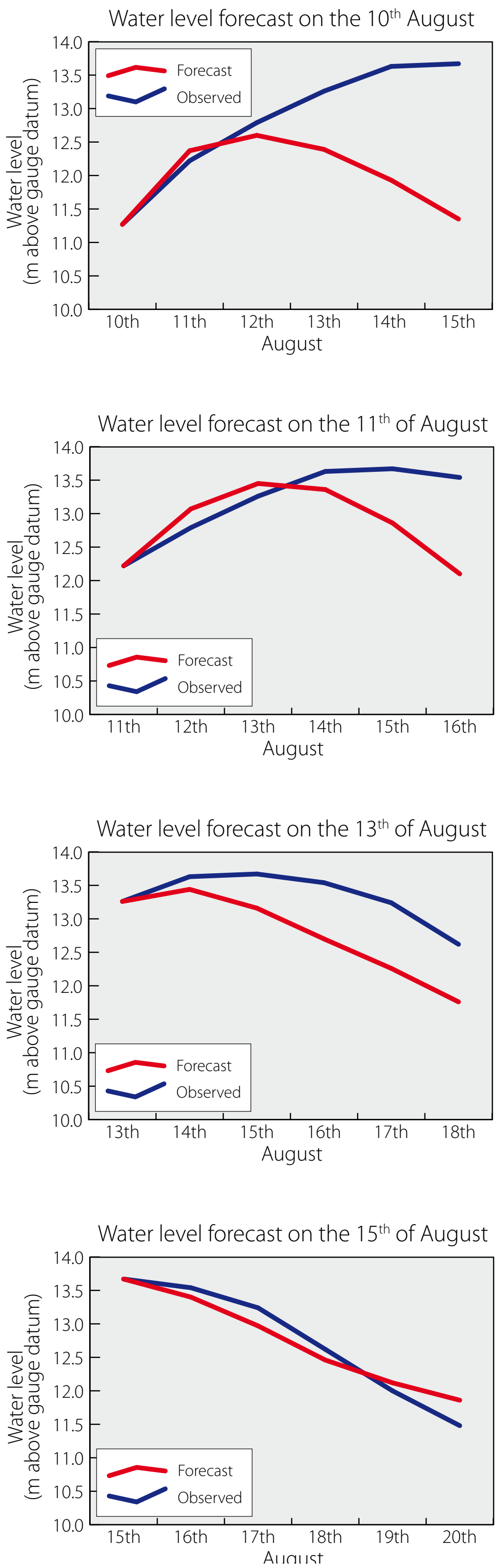
11. Lessons learnt and recommendations

The August 2008 event was the first regional flood episode for which active forecasting was instigated by the RFMMC, and on the whole results were encouraging. Clearly, certain questions have arisen and there are lessons to be learnt. These fall into three categories: (i) those with regard to the data, (ii) those with respect to the modelling and accuracy of the forecasts, and (iii) those concerning the dissemination and communication of the outputs.

Data and information

- The role of the rainfall data in forecasting water levels needs to be reviewed. As the lead times increase, rainfall data assumes a greater role over the routing in determining overall accuracy. However, the fall off in precision suggests that more rainfall data are needed in many areas of the basin, particularly where the major volumes of flood runoff are generated.

- Improvements in data coverage are particularly needed within the major tributaries in the Lao PDR north of Luang Prabang, where at least half of the August flood runoff was generated. Here data for calibrating the hydrological component of the overall model are limited. A start could be made by considering the historical role that these tributaries played in past events, with that of 1966 providing the benchmark.



1. The forecast on the 10th accurately predicted that water levels would exceed the flood level of 12.5 m within 24 hours. However, the forecast was for this exceedance to last for only one day, after which levels would decrease steadily. In fact they continued to increase until the 15th when the maximum of 13.67 m was reached, more than 1.5 m greater than the forecast peak water level. This shows the decrease in accuracy beyond the two-day forecast.

2. One day later, on the 11th, the forecast of the maximum water level was much better, with only a 20 cm error in the predicted peak water level. However, while this was expected to occur on the 13th, it actually happened on the 15th.

3. The forecast of the 13th predicted peak water levels to occur on 14th. However, the peak occurred one day later, on the 15th. The forecast of the height of the peak was good, being only 15 cm in error. However, the water level fell more slowly than forecast.

4. By the 15th, the day on which the peak water level occurred, the rate of flood recession was predicted accurately.

Figure 14. Performance of the one- to five-day forecast of water levels at Vientiane on the 10th, 11th, 13th, and 15th of August.

- Satellite imagery of flooded areas is most valuable. The MRC has already contracted a specialised agency to provide images, so that flood situation reporting can be complemented by near real-time visuals.

- Inundation maps should be made available for the whole basin, and risk maps should be prepared for those areas under significant threat of flooding. Some exist for certain areas, and this activity should be expanded prior to the next flood season.

- During the course of the event, it also became apparent that along with the daily provision of water levels from the AHNIP (Appropriate Hydrological Improvement Project) and HYCOS (Hydrological Cycle Observation System) stations, at a minimum of three-hourly updates is required. Data loggers should be placed in an automatic one- to three-hourly automatic transmission mode during the flood season.

- Even though the role of the three existing mainstream reservoir storages in Yunnan on the volume and peak discharge of major floods in the northern areas of the Lower Mekong Basin remained insignificant, the flood event clearly demonstrated the usefulness of early notifications of planned reservoir releases during flood events. Information with (if possible) a lead time of five days would be most useful with regard to the three existing mainstream reservoir storages, as well as from larger tributary reservoirs and construction sites in the Lower Mekong Basin countries. The MRC is well placed to provide advice on the sequencing and timing of potential releases from a regional flood management perspective, particularly for larger schemes currently under construction.

Flood modelling capability and forecast accuracy

- The weight given to the rainfall data, and therefore to the tributary runoff, tends to cause fairly substantial oscillations in the predicted water levels from day to day, particularly for the longer lead times. This is not reassuring for the end user, and the day-to-day variance of the forecasts needs to be reduced. Attention is required with regard to the implementation of 'learning algorithms' and feedback methods which the flood forecasts allow to be refined and 'damped' as the event evolves. In the short term a knowledge base should be built up of major regional storm events. This could can be used develop flood modelling capability.

- Hydrometric data provided by China proved to be extremely important, as it provides a solid starting point for the flood routing on the mainstream. However, this information is not yet used to its full potential. The relevant parts of the forecasting model require review and improvement.

- All in all this recent flood has provided an excellent opportunity to build on improvements being implemented, and to continue to review the performance of the flood forecasting technology in the Mekong Basin, both hydrologically and statistically. A formal report on the review is planned.

Dissemination of flood forecasts and early warning

- Institutional arrangements to disseminate MRC forecasts and early warning need to be reviewed, in terms of their usefulness for counterpart agencies, their distribution channels and selection of recipients. For instance, in addition to the web based dissemination of forecasts, the RFMMC communicates forecasts and early warnings via daily emails to some 50 subscribers. A pro-active and more strategic approach to identify and target additional interested parties could be warranted.

- This is the first year that flood forecasts have been featured through the MRC's home webpage. Feedback on further improvement in presentation and communication with the media will be actively considered.

Flood preparedness

- The recent event may also provide practical lessons to improve and further focus flood preparedness activities in selected provinces in Cambodia, the Lao PDR and Viet Nam, which are carried out under FMMP Component 4.

The MRC's Flood Management and Mitigation Programme (FMMP) has developed a preliminary plan of action to address these points and this will be discussed at a forthcoming Steering Committee Meeting on 12th September 2008 in Hanoi.

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