

# Remote Sensing for Delineation of Breaches along the Embankments of Indus River during Flood 2010

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Remote sensing plays a key role in disaster mapping, monitoring and damage assessment as it can provide near real time data of the affected areas.

The major damages during 2010 Floods had occurred due to breaches on embankments along the river Indus. These breaches can easily be delineated using satellite remote sensing. The rehabilitation of embankments can also be monitored using this technology. SUPARCO undertook a study to delineate the breaches, progress of there rehabilitation work this also led to determination of areas where additional embankments/protective bunds or reinforcement are required.

The methodology for delineation of breaches and rehabilitation of embankments consists of two phases: firstly the identification of breaches by comparing satellite images acquired during-flood with the pre-flood images, secondly for validation, the status of embankment repair was performed, comparing the during-flood images with the post-flood images.

## 1. During-Flood Study: Delineation of Breaches

The delineation of breaches could be carried out by observing any high flow of flood water outside the embankments. Once a breach along the embankment or canal is identified, the length and status during pre and post flood situation is analyzed. The comparative analysis with a pre flood image gives the information about the condition of embankment before the flood. Assessment reveals 141 breaches all over the country among which 60 were delineated in Punjab while 76 in Sindh. Most of the breaches were byproducts of three main breaches that are Left Marginal Bund (LMB) in Punjab, Tori and Kot Almo in upper and lower Sindh respectively. Figure 1.1 shows the breach in LMB of Taunsa barrage which bursted and produced 1900 meter long breach. This breach created a lot of damage in Layyah, Bhakkar, and Muzaffargarh Districts. Several breaches formed as a consequence of LMB breach in adjacent bunds and canals particularly left bank canals (Muzaffargarh Canal, Taunsa-Punjadn Link Canal) of Taunsa barrage.



Figure 1.1 LMB Breach near Taunsa Barrage, Punjab

In Sindh, a breach which almost diverted the whole flow of water of the Indus River is Tori breach. Figure 1.2 shows the Tori breach on River Indus which caused multiple breaches in canals and roads. Tori breach resulted in vast destruction in the province particularly in Kashmore, Jacobabad, Qambar, Shahdadt and Dadu. The water flow on the right bank of

Indus is obvious because of the natural depressions in the north western part of Sindh. Tori breach resulted in producing number of breaches in canals and roads and caused a major loss of infrastructure.

Few embankment breaches are not very destructive because of the presence of second defense line of embankments. Breaches in some of the areas where the image was captured a few weeks after the flood are temporarily filled, so the flooded area should be vigilantly examined to delineate such breaches. The temporarily filled breaches were identified by the uneven filling of embankments.

Destruction of infrastructure creates a major hurdle in evacuation and rehabilitation especially due to the roads getting damaged. Figure 1.3 shows a 60 meter breach which occurred on Dadu-Moro road embankment on Indus river (links National Highway N-5 to Indus Highway N-55) produced a major infrastructure loss as it disconnected the residents of left and right bank of River Indus in this region.

## 2. Post-Flood Study: Validating the Breach Rehabilitation Status

After delineating the breaches, the second phase of the study involved the monitoring of the status of breach rehabilitation and restoring work. This phase needed to have a comparative analysis of the during-flood images with the post-flood images. The monitoring revealed that by the month of April 2011, some of the embankment breaches remained unattended while many of the embankments and canal breaches were temporarily filled and could not be restored completely.

The Tori breach in Sindh and LMB in the Punjab were filled on urgent basis since these had caused major destruction over large areas. Figure 2.1 shows the rehabilitation of Tori embankment breach. It was quite difficult to repair the old breach, so new parallel embankment was constructed to fill the breached area of Tori. Other consequent breaches of Tori (Old Ghauspur bund and the

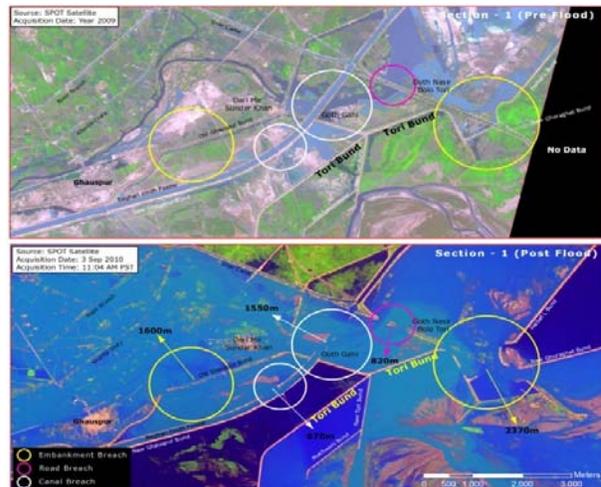


Figure 1.2 Tori Breach in Sindh



Figure 1.3 Dadu-Moro Road Breach, Sindh



Figure 2.1 Rehabilitation of Tori Breach, Sindh

embankments of Beghari Sindh Feeder) were also rehabilitated as shown in Figure 2.1.

Kot Almo Bund breach in district Thatta also destroyed a large area of agricultural belt of lower Sindh. An important city of Sujawal was seriously affected by flood water which rushed from the Kot Almo bund. These breaches were filled on priority bases as shown in Fig 2.2. It is to be noted that two defense lines of protective embankments are present. But the water exerted immense pressure on the embankments so that both the defense lines broke and water rushed through. Later on, both the embankments were rehabilitated.

Some of the breaches which are repaired on priority basis not during flood are renovated up to the standards and that the width of the protective embankments can not be maintained. Some of the breaches are temporarily filled by creating a curved structure. Such filling are considered as partially repaired breaches. These bunds are then required to be redone in the most professional manner to maintain the next flood. Figure 2.3 shows such partial filling of Muzaffargarh canal breach, district Muzaffargarh in Punjab.

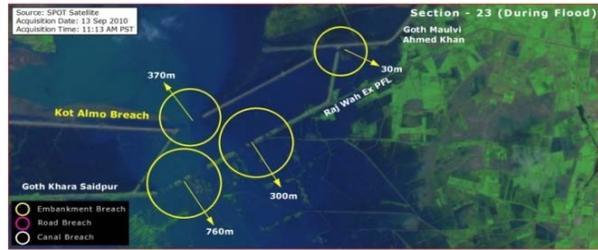


Figure 2.2 Kot Al'mo breach, District Thatta, Sindh



Figure 2.3 Filling of Muzaffargarh Canal Breach, Punjab

## Conclusion

Flood - 2010 is to be considered as a benchmark for preparedness programs to avoid the future calamities and for reducing the loss of lives, property and infrastructure. The work demonstrates the potentials of satellite remote sensing for mapping and monitoring of natural disaster and the important role space technology applications can play in disaster monitoring & mitigation. It is imperative that the potential of such modern technologies be fully exploited by all stake holders to find solution to minimize disasters as was caused during 2010 flood.