

## **Study of Road Embankment Erosion and Protection**

Two main areas of focus:

- Roads running close to major river channels, subject to periodic flood damage; and
- Roads on embankments, far from river channels but badly affected in high flood years.
- First is quite limited in extent.
- Second can be a serious, widespread problem.



## **Roads close to major rivers: the problem**

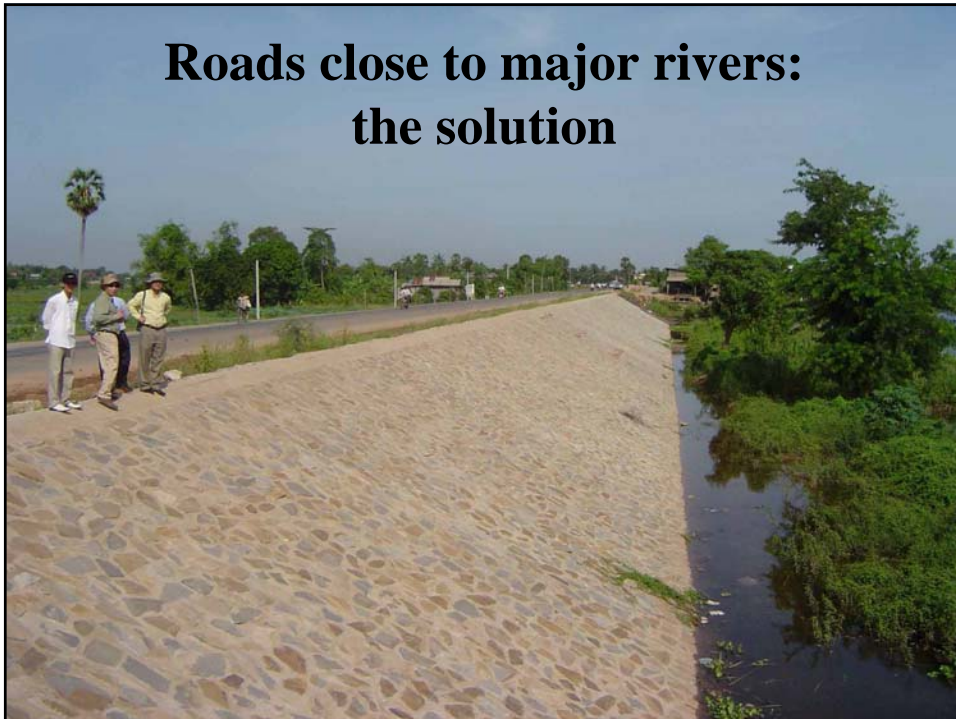
- Major rivers mean the Mekong, Bassac and Tonle Sap.
- This is a dynamic lower valley location, with an active flood plain environment and vast hydrological throughput and energy.
- Shifting of river channels is a continuous natural occurrence.
- Complex interactions of other factors, particularly land use, sand dredging and navigation.
- Most roads are at a good distance from major rivers.
- Most bank failures are on the outside of bends and involve small shear failures in deep, unconsolidated alluvial soil.

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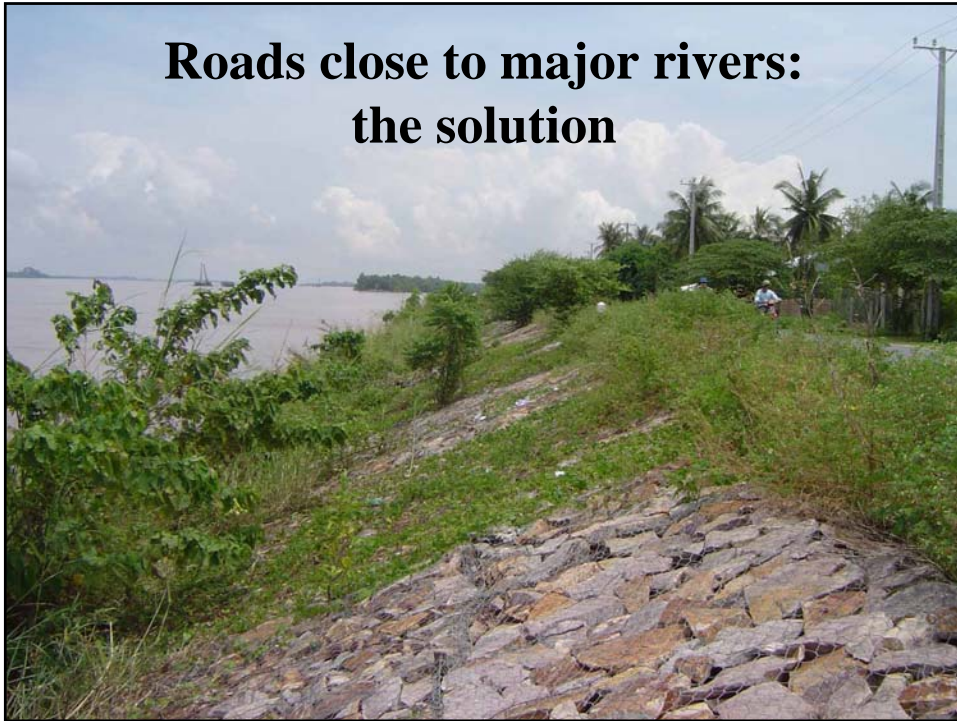
## Roads close to major rivers: the solution

- **Prevention** of bank erosion is possible over short lengths using surface facings of substantial earth embankments.
- Examples will follow of mortared masonry facings on RN 1 and gabion facings on RN 11. Flexibility and free drainage are usually important.
- There is evidence that the presence of bands of large trees slows down the rate of bank retreat, but does not stop it.
- **Cure** of existing problems is straightforward: usually requires a gabion retaining wall built in the low water season.
- Appropriate design drawings exist from the MPWT's Emergency Flood Rehabilitation Project.
- There is a limited need for further research.

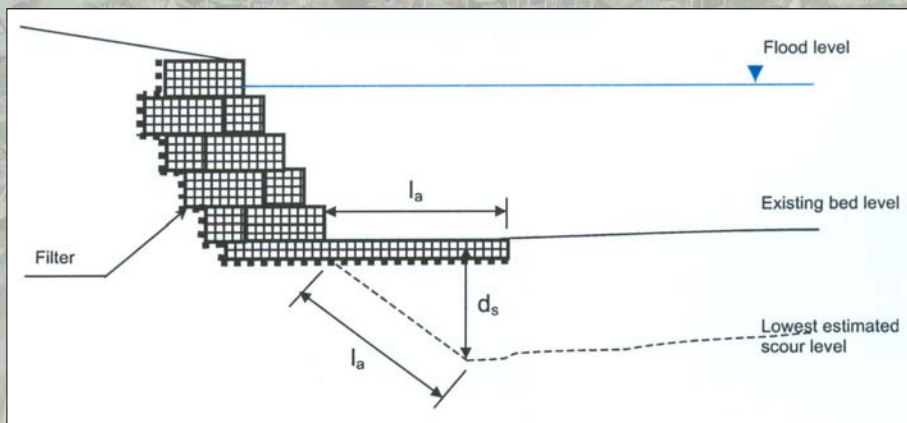
## Roads close to major rivers: the solution



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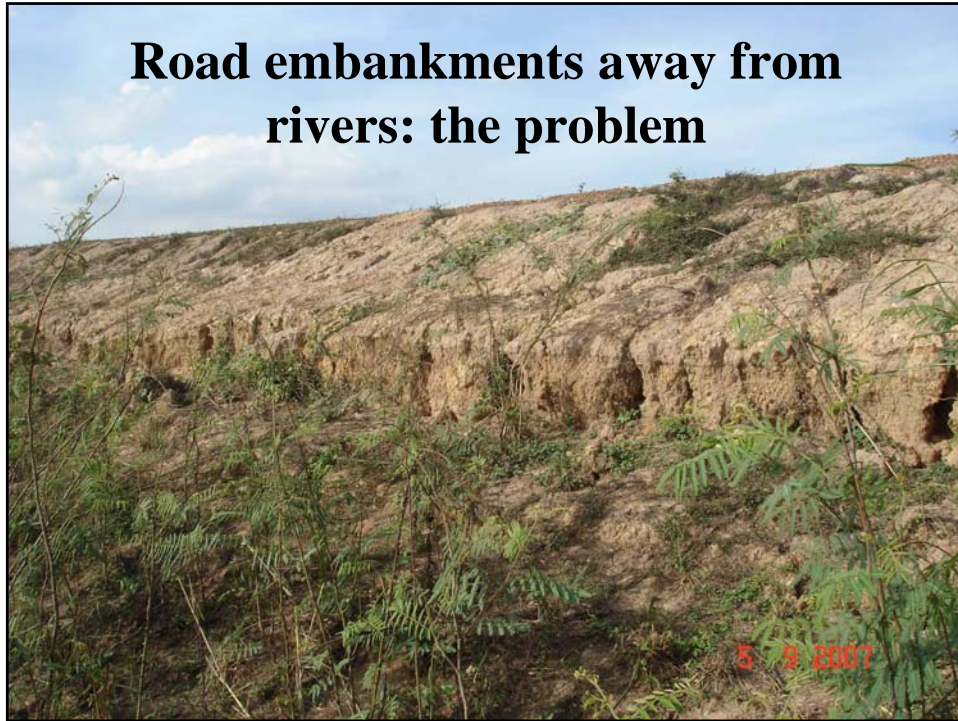


## Roads close to major rivers: the solution



Design from Expert Report on Embankment Erosion, November 2002, Scott Wilson Kirkpatrick & Co. Ltd, Emergency Flood Rehabilitation Project.

## Road embankments away from rivers: the problem



## Road embankments away from rivers: the problem

### What is known

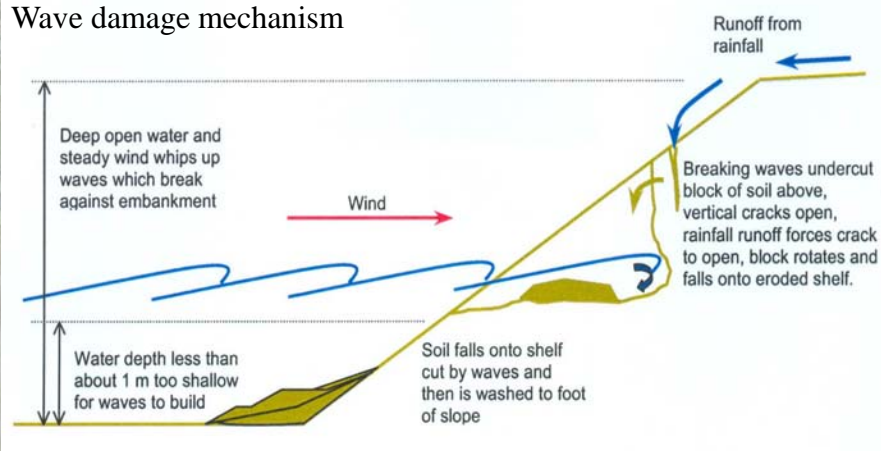
- Large expanses of sitting water allow waves to erode road embankments. In severe cases this can make roads impassable.
- This problem occurs mainly where there is little vegetation to protect the embankment sides.
- In very high floods, over-topping of embankments causes even more damage.
- Simple earth embankments are rarely given adequate protection from rain and runoff erosion, and many roads are already damaged by that.

### Uncertainties

- Every flood has different characteristics, because of annual climatic variations and the Mekong's complex hydrology.
- Rapid development means significant land use change, and therefore changing impacts on floods.

## Road embankments away from rivers: the problem

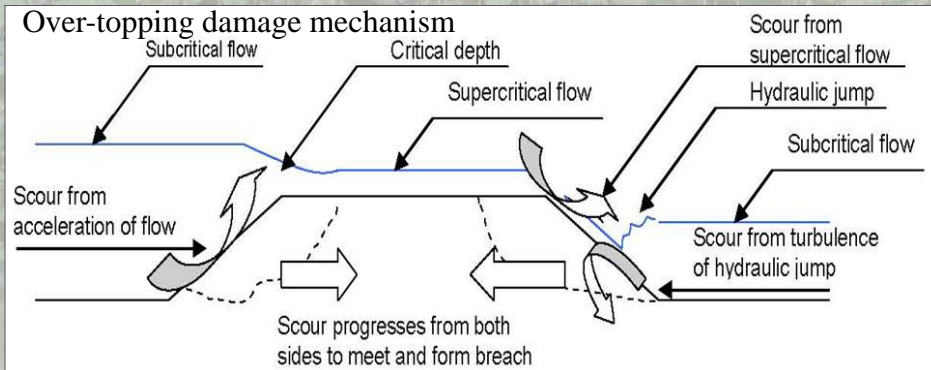
### Wave damage mechanism



From Expert Report on Embankment Erosion, November 2002, Scott Wilson Kirkpatrick & Co. Ltd, Emergency Flood Rehabilitation Project.

## Road embankments away from rivers: the problem

### Over-topping damage mechanism



From: Yit, B. 2004. Risk Management and Mitigation for Flood and Sediment Disaster. Cambodian Country Paper for International Conference.

## Road embankments away from rivers: the problem

### How big a problem is this?

- It occurs mainly in severe flood years (e.g. 2000, 2001, 2002).
- But it also occurs on some roads in normal years, where standing water causes wave damage.
- When it occurs in bad floods, it is very widespread: 1,800 km of national roads and 820 km of provincial roads damaged in 2000.
- There are more roads built each year, and they are mainly on flood plains.
- Loss of road embankments severely affects disaster relief.
- Loss of infrastructure adds greatly to post-flood rehabilitation costs.
- Surface erosion of embankments is also a costly problem (from rain and runoff).

## Road embankments away from rivers: the solution

### Situation

- Most roads on flood plains are at risk: possibly 10,000 km.
- Flood plain embankment roads are not adequately designed for the environment in which they are built.
- Roads tend to fail when they are most needed.

### Constraints

- Very long lengths of road embankments need to be protected.
- All categories of roads are affected, including low traffic roads.

### Implication

- The solution must be as low in cost as possible.
- Only vegetation is cheap enough to be used very widely.

### Implementation

- There is already some experience in Cambodia.
- Much information can be applied from outside the country.

**Road embankments away from  
rivers: the solution**



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### Limitations to wider use of vegetation

- Useful observations can be made from embankment slopes already protected with vegetation.
- But a number of technical issues still need to be satisfied.
- A series of treatment systems must be refined that are robust, practical, cheap and easy to apply.

### Research required

- Focus on improving techniques and configurations of planting.
- Refinement of species selection, using Cambodian plants.
- Development of straightforward systems that serve engineering requirements in a cost effective way.
- Generation of practical outputs to enable the MPWT and MRD to implement these methods as a routine activity.

## Summary of the proposed way forward

### Research strategy

- Mainly focus on low cost, vegetation-based protection of road embankments at a distance from roads.
- Additional work to resolve remaining uncertainties of river bank erosion affecting roads.
- Strong emphasis on making existing and new knowledge available in a timely way.

### Suggested implementation arrangements

- MPWT should take the lead as the agency with the biggest interest.
- Research to involve ITC and MRD as key research collaborators. The irrigation sector (through the MWRM) may also be important contributors.
- Methodological and documentary outputs are specifically to serve the two ministries' immediate needs.

