

Urban Flood caused by Inappropriate Waste Management in Asia: Adaptation to Climate Change

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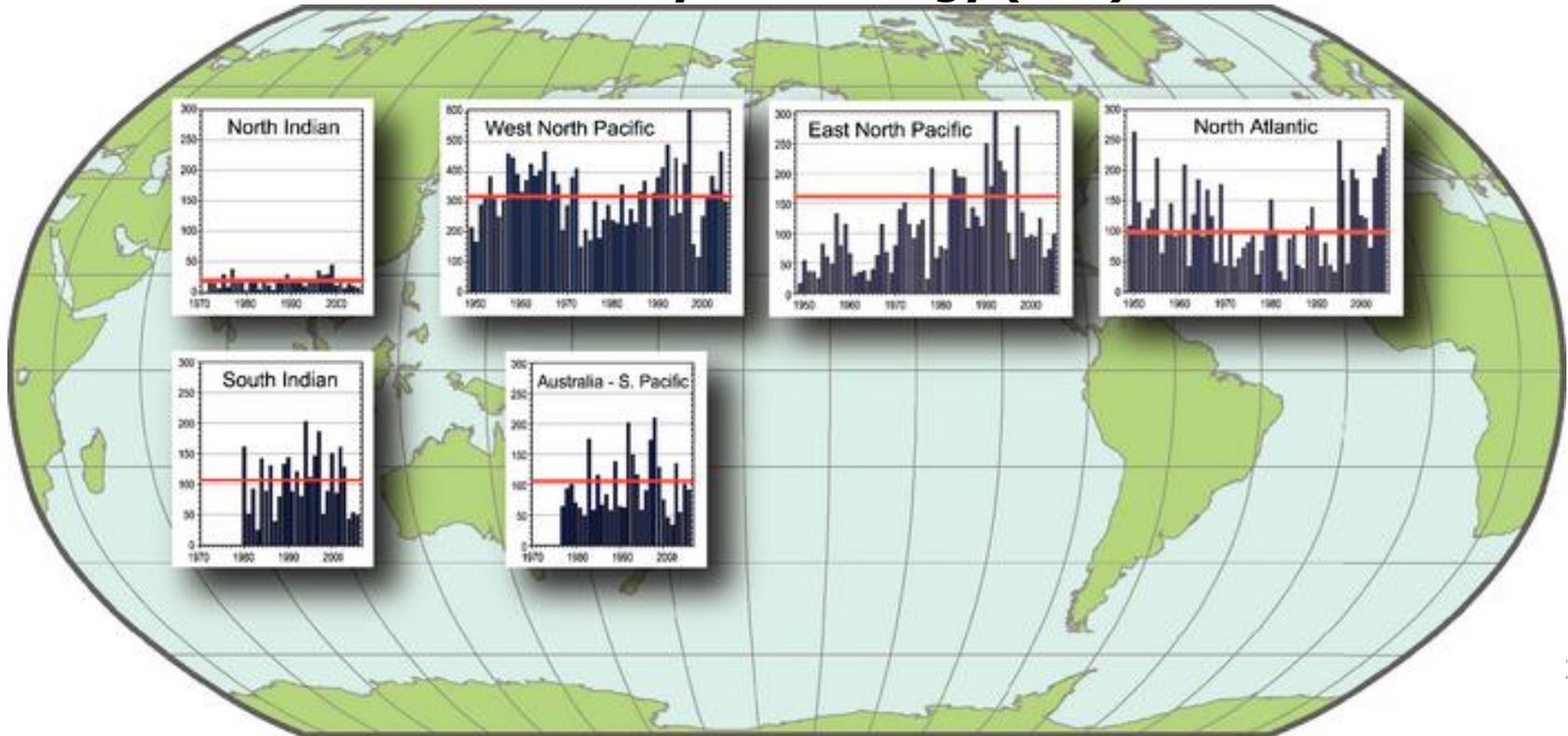
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Century of High Disaster Risk

Frequency and **Intensity** of extreme events has been increased as a result of human influences on climate. Climate change may be perceived most through the impacts of extremes, although these are to a large degree dependent on the system under consideration, including its vulnerability, resiliency and capacity for adaptation and mitigation. (ref IPCC AR4)

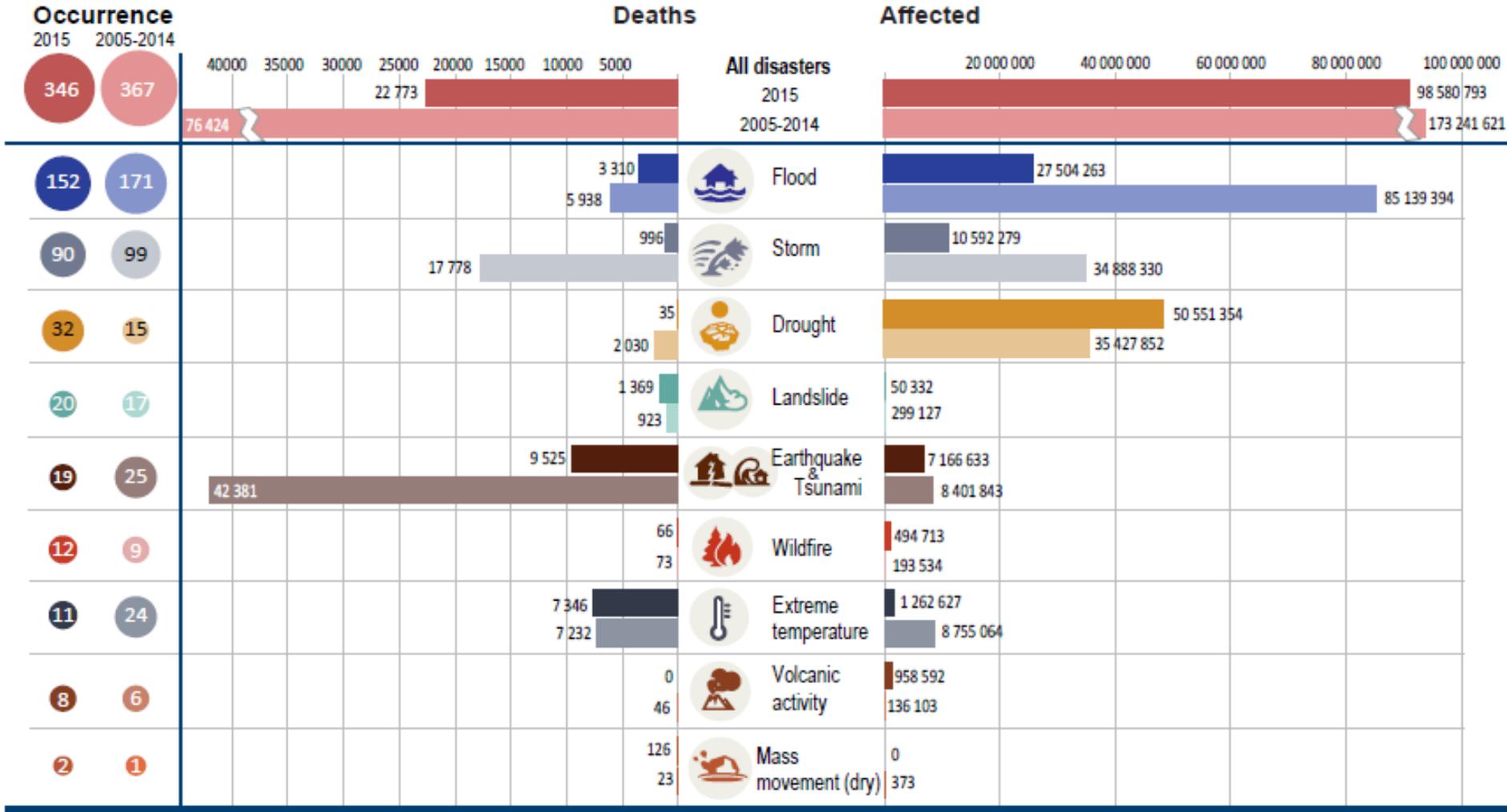
Accumulated Cyclone Energy (ACE) index



Major Natural Disaster

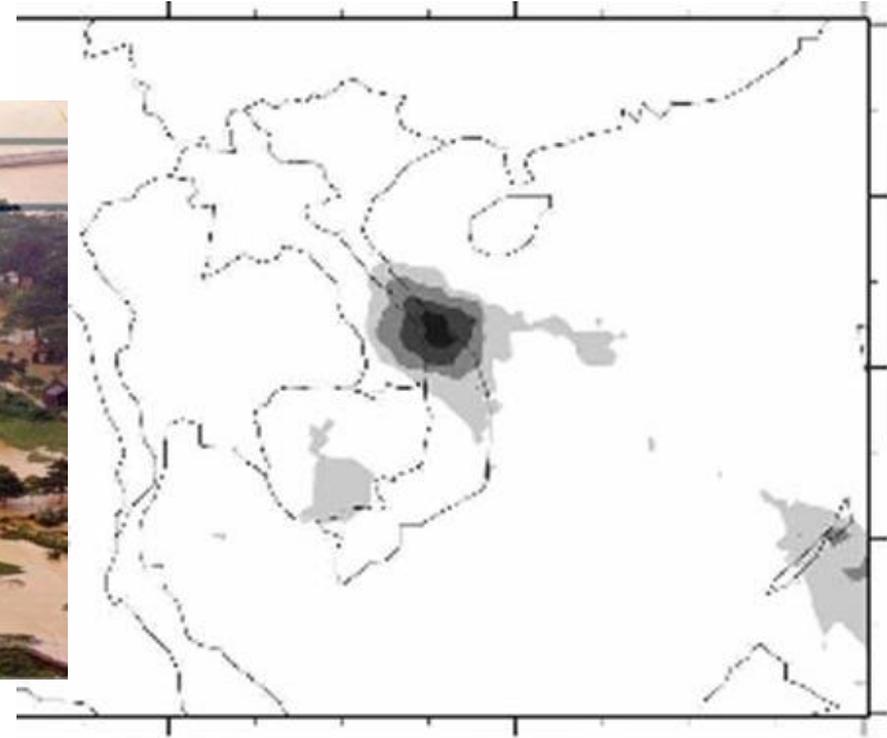
- Cyclone (Hurricane, Typhoon)
- Tornado
- Flood
- Earthquake and Tsunami
- Eruption of Volcano
- Drought
- Cold wave
- Abnormal Weather (continues rain, rain in dry season, etc)

Damages by Natural Hazards



World's Heaviest Rainfall

1630 mm in 24 hour, Truoi, 1999



Hue had also received 1,433 mm of rainfall in 24 hours
622 people died, 42,000 houses were destroyed

“Historic” Flood in Hue (7 Nov. 2017)



Continuous heavy rains have worsened the inundation due to heavy floods that occurred on Sunday morning in central Thừa Thiên-Huế Province. **Water covered almost all roads** connecting the districts with National Highway No. 1A, which opened to traffic late Monday afternoon when water receded following the **nearly two-day inundation**.

Residents in the province blamed power plants located at the upper parts of two local main rivers of Hương and Bồ for the unannounced release of water into the rivers. However, the responsibility for this fell on district and commune authorities, as last Friday, local newspaper had carried related announcements.

Bangkok hit by flash floods (15 Oct. 2017)



“Areas of Thailand's capital, Bangkok have been **severely disrupted after being hit by flash floods**. The floods triggered by an overnight downpour were the heaviest Bangkok had seen in 25 years and **overwhelmed the city's drainage system**. The water took six hours to recede in some area of the capital. At least 55 major roads were submerged by floodwater which caused traffic jams across the capital with locals forced to wade through thigh-deep water.”

BKK Governor: Rubbish-free drains to help prevent floods (Bangkok Post, 15 June 2015)



“Bangkok governor has ordered his city workers to speed up **collection of drain-clogging rubbish in the city to prevent future flash floods** as heavy rain is expected to hit the capital again this week.”

APN funded project:

Appropriate Solid Waste Management towards

Flood Risk Reduction through Recovery of

Drainage Function in Tropical Asian Urban Cities



Project Methodology

Target cities: Hue, Vietnam and Bangkok, Thailand

**Field
investigation**

**Mathematical
modelling**

**Social
surveys**

Workshop

Outreach

Outline of the Project

Component 5

- ✓ Interview survey to waste management division

Current waste collection strategy and its challenges

Component 4

- ✓ Interview or questionnaire survey to local residents

Psychological factors for waste dumping

Strategy to reduce urban flood risk through appropriate waste management

New strategy for waste collection New strategy for awareness raising

Potential of drainage capacity improvement by waste removal

Drainage capacity considering waterway blockage by waste under different flood scenarios

Drainage capacity under normal situation

- ✓ Interview survey to Sewerage division
- ✓ Review of gov. publications

Component 1

Composition and amount of illegally dumped waste in public space (water channels)

- ✓ Field survey (incl. monitoring and waste sampling)
- ✓ Composition analysis

Component 2

Waterway blocking potential of wastes

- ✓ Numerical modelling
- ✓ Lab-scale experiment

Component 3

Component 6

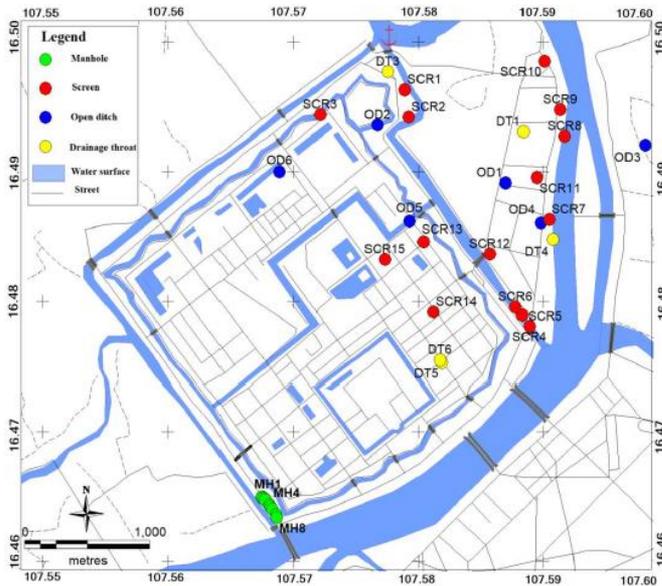
Capacity development workshop for local waste management officers

Survey on debris in canals

Amount and composition of debris in canals in Bangkok and Hue



Situation of Hue city

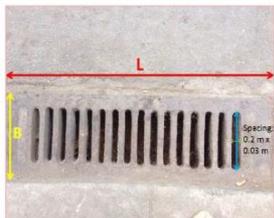
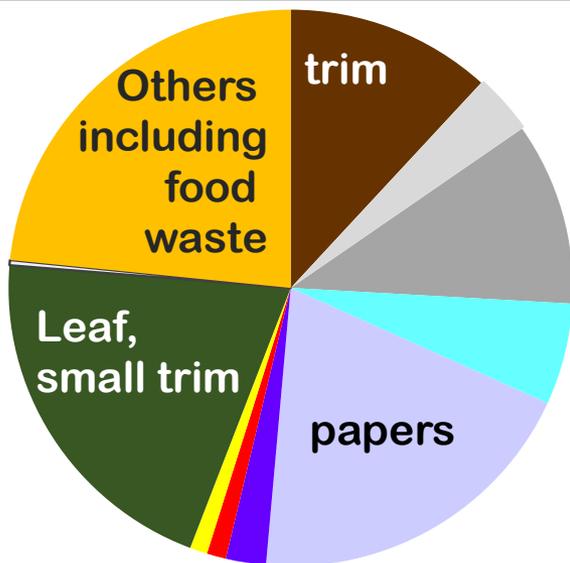


There is networking of trench for the purpose of castle guard, which connects to river water. That is not wide and straight, but curved or bent trench, suggesting to generate flood water easily. Underground- ditch drainages connecting to river. Hue was historically famous for seasonal flooding caused by monsoon climate. The construction of the dry dam in the upstream can successfully reduce the risk of big flood disaster in a decade though there are still seasonal inundation in the residents every year. The major trigger of urban inundation occurred by the overflow of the river dike during the prolonged precipitation, or increase of water level of urban canal due to exceeding the capacity of drain floodwater.



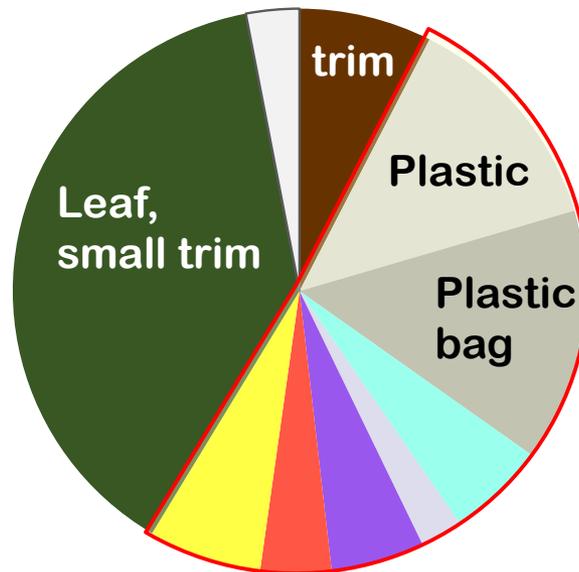
Composition of Debris in Drainage: Hue

on road screen



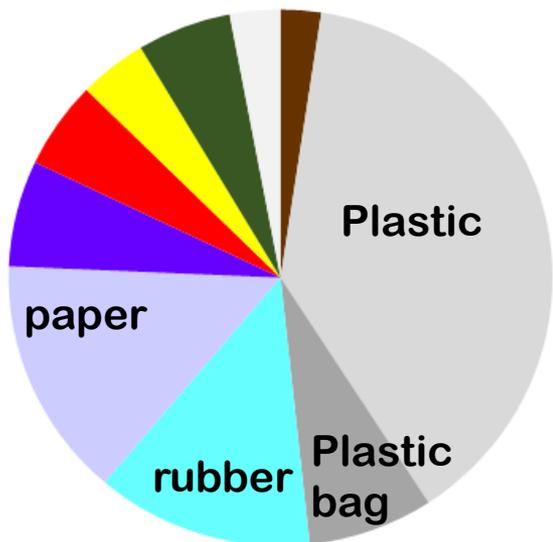
Natural derivatives from deciduous tree or food waste disposed to street were effectively caught at screen

at open canals

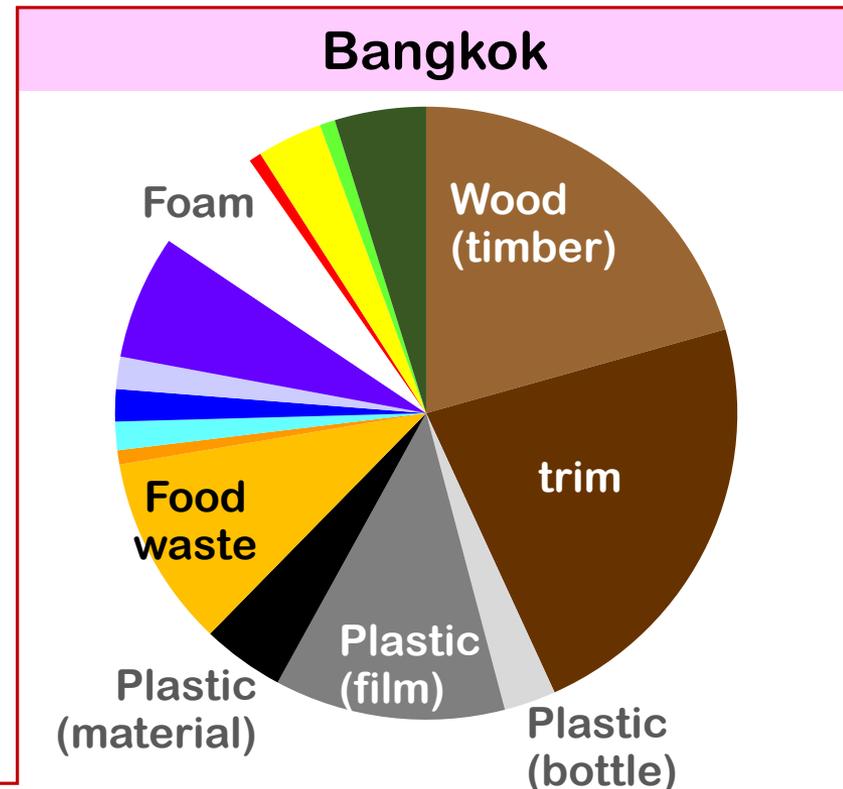
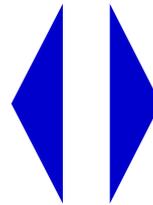
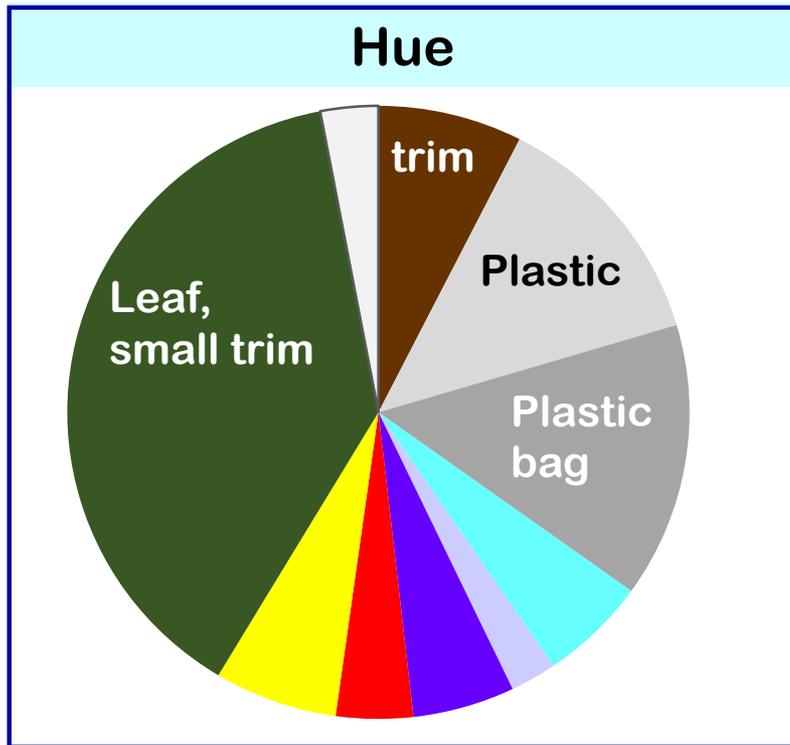


Artificially disposed waste was comprised about 50%.

in manhole



Comparison of Hue and Bangkok



- **Timber** derived from Construction and Demolition waste
- **Food waste** disposed by residents



Numerical Modelling of Drainage clogging

Simulation of urban flash flood

Debris in canal



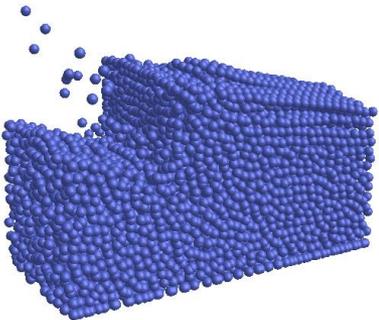
Drainage clogged



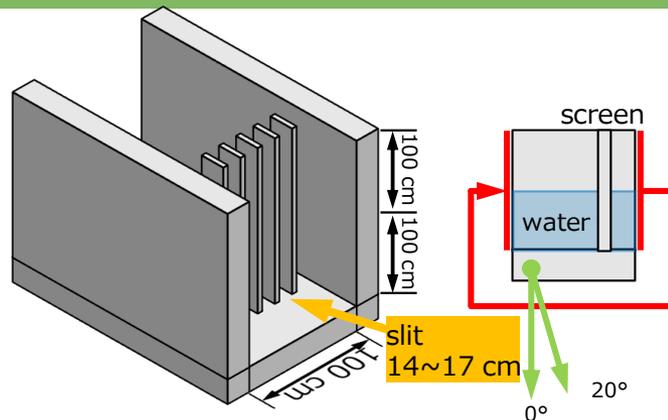
Urban flood



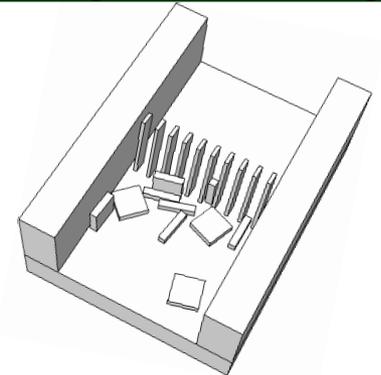
Smoothed Particle Hydrodynamics



Combination of models using real parameters in canal



Bullet Physics Library



Social Survey on Waste Disposal Behavior

“Why do people throw away waste into canals?”

- Q How do people living along canals throw away their daily/bulky waste?
- Q What kind of people throw away waste inappropriately?
- Q Why do people behave in such way?
 - Is it an issue of awareness? Or is it the collection system?



Proposals from the Project (1/3)

- Even if the public waste collection services are provided enough and appropriately for residents from viewpoint of solid waste management, the **unintentional disposal** of solid waste to canal must have strong impact on increasing flood risk.
- It is necessary to reconsider the **collection frequency, zoning of collection, or container size** nearby canals as immediate countermeasures on urban inundation.
- In terms of long-term sustainable management, redevelopment of canal front and public welfare for low-income residents.



Proposals from the Project (2/3)

- **High-density debris** in the canal is strong factor to increase the water level and inundation area.
- Drainage management section are required to **remove the debris** not only from surface but also from the deeper zone of the canals.
- It is recommended that the debris collection should be conduct intensively **before and during rainy season**.



Proposals from the Project (3/3)

- **Construction and demolition** is a key industry. Not only the construction or demolition project in canal front, but also inappropriate disposal of the debris to the area in canal front or riverside must be regarded as major source of high-density debris in the canals. Appropriate control of this activity will contribute to reduce the urban flood risk.

