Natural hazard and territorial planning:
Using digital topographic data
to capture the flood footprint

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Outlines
• Earth landforms and physical processes
• Digital global earth data
• GIS terrain analysis for capturing the flood footprint:
  introducing a DEM-based floodplain delineation model
• Flood risk and territorial planning: Standard flood maps vs floodplains
Earth landforms and physical processes

Earth physical processes modelling issues:

- Scenarios/Frequency
- Data accuracy
- Statistics/Deterministic
- Validation
- …

UNCERTAINTY

http://www.agci.org/classroom/images/earth_system_diagram_big.jpg

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Earth landforms and physical processes

Weathering
Erosion
Deposition
Landslide
Fluvial processes

LANDSCAPE EVOLUTION
Digital Elevation Models

http://www2.jpl.nasa.gov/srtm/

Digital Earth

Next-generation Digital Earth

A speech of the late President Al Gore in 1998 created a vision for a Digital Earth generation of virtual globes, epitomized by Google Earth, that allowed everyone to see the beauty of the earth from space, to understand the complexity of the Earth, and the functionality of the first generation of virtual earth developments in technology continue, the era of "big data" has arrived, through the use of science and cross-disciplinary, and advances have been made in all fields, and the public's access to science. All these factors prompt a reconceptualization of the elements that should be part of a next generation.
High resolution DEMs

Aerial and satellite remote sensing (LIDAR, UAV - SRTM, ASTER)

Field surveys (GPS, Laser scanner, UAV)

Sensing the Earth

Observing and interpreting urban and natural features…
Floodplains

Floodplains are critical landscape features that are highly distinguished from neighboring uplands in terms of their hydrologic, geomorphologic, biogeochemical and ecological processes.

Floodplains

Floodplain topography intrinsically contains information on the hydrogeomorphic signature of past erosional and depositional processes. Digital Elevation Models (DEM) implicitly contains the floodplain information on the floodplain-related physical phenomena.


Terrain Analysis

Analyzing terrain surface properties (elevation, land use,..) for deriving hydrogeomorphic parameters:

Direct: slope, curvature, aspect
Indirect: flow direction, drainage area

Features:

stream network, drainage basin, floodplain, hillslope

Processes:

deposition, erosion, land/water dynamics (i.e. landsliding/flooding)
Terrain analysis applications

Water flows along the steepest slope

Filling sinks
Flow direction
Contributing area
Watershed delineation
Stream Network

Hydrologic processing of DEMs for stream network extraction
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Hydrogeomorphic floodplain delineation

Inundation depth: $h$
Contributing area: $A$

Leopold law scaling parameters:

$$h = aA^b$$

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Po river basin (North Italy)

Area 75,000 km²
Channel flow depths: up to 44 m
Stream network source contrib. area: 500 km²
Floodplain area: 5178 km² to 14976 km²

500 yrs Flood/Inundation maps
> 10,300 km²
Lake areas: 1000 km²
Floodplain area:
5178 km² to 14976 km²
Tiber river basin (Central Italy)

Area 17,500 km²
Channel flow depths: up to 25 m
Stream network source contrib. area: 500 km²
Floodplain area:
760 km² to 1455 km²
200 yrs flood maps: 436 km²

The Tiber river case study

How do the hydrogeomorphic floodplain behaves as respect to standard flood/inundation maps?

The Tiber river case study

Nardi F., Biscarini C., Di Francesco S., Manciola P., Ubertini L., *Irrigation and Drainage*, 2013

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Tiber river basin (Central Italy)
Tiber river basin

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Territorial planning for minor river basins

Lazio region - City of Rome
Flood risk management plan

Simplified analyses:
- flood prone area delineation
- River-road intersections
- Hydrologic pathways

FLOOD VS FLOODPLAIN mapping

City of Rome – Flood risk management plan
River-Road intersections

Large scale hydrologic analyses

Information for territorial planning:
- Floodplain
- Critical river nodes
- Hydrologic pathways
Discussion

- Capturing river basin physical processes and features using digital topography (DEM)
- Understanding flood risk by evaluating the geomorphology of floodplains and critical human-made features
- Integrated flood risk management and territorial planning by considering the hydrogeomorphic flood footprint rather than event-base standard flood mapping

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