"In my country the rain does not know how to rain
or little rain or too much rain;
if it rains a little: the drought
if it rains too much: the catastrophe"

RAIMON

EGU GENERAL ASSEMBLY 2015
Vienna, 14 April 2015

European Geosciences Union
General Assembly 2015
Vienna | Austria | 12 – 17 April 2015

Source: Las Provincias

A G.I.S.-based Model for the Hydrological and Hydraulic Reconstruction of Historical Flash-Floods in Urban Areas. The Case of the River Turia in València (1957).

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HS4.1/AS1.22/GM7.12/NH1.10
Flash floods, hydrogeomorphic response, forecasting and risk management (coorganized)
Convener: Isabelle Braud

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JOINT RESEARCH FRAMEWORK

- HYDROLOGICAL & HYDRAULIC STUDY FOR THE RECONSTRUCTION OF THE URBAN FLASH-FLOOD OF THE RIVER TURIA IN VALENCIA 14 OCTOBER 1957

JUSTIFICATION

- WHY:
  - DETERMINE REAL MAGNITUDE OF THE BIGGEST HYDROLOGICAL-HYDRAULIC RECENT EVENT
  - FUTURE INFERENCE WITHIN A HIGHLY MODIFIED METROPOLITAN ENVIRONMENT
- WHY NOW:
  - RESEARCH OF BOTH UNPUBLISHED & RICH MATERIAL
  - AVAILABILITY OF TECHNOLOGY & THE IMPLEMENTATION OF A NEW WORKING METHOD

Source: Carmona & Ruiz

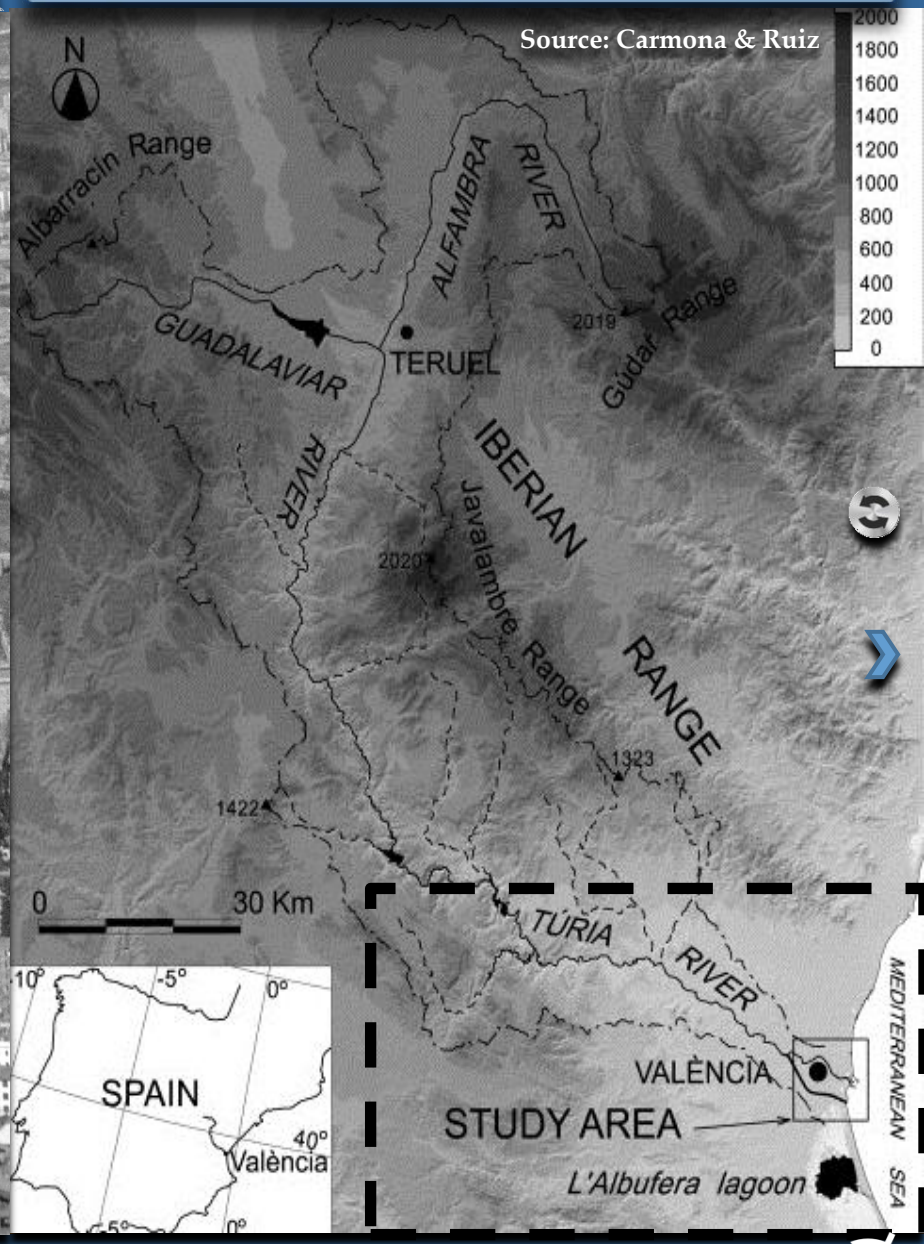
GEOGRAPHICAL CONTEXT (1957)

- RIVER TURIA'S URBAN STRETCH
  - VALENCIA (EASTERN SPAIN): 500.000 INHABITANTS
  - BASIN GEOMORPHOMETRY:
    AT=6.400 KM^2, L=280 KM, ΔZ= 2,000M, I=0.007M/M
  - CHANNELLED REACH: L=10KM , W=150M, AVERAGE DISCHARGE=14M^3/S

A GIS-based Model for the Hydrological and Hydraulic Reconstruction of Historical Flash-Floods in Urban Areas. The Case of the River Túria in València (1957)

Source: AHMV

Source: Carmona & Ruiz



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THE LOWER TURIA SYSTEM (1957)

- **MEDITERRANEAN BASIN**
  - **RAVINE CHARACTERISTIC**
    - SHORT LENGTH, HIGH SLOPE
    - EXTREMELY IRREGULAR DISCHARGE
  - **CLIMATE**
    - COLD AIR POOL PHENOMENA -> HEAVY RAINFALL EVENT
- **RIVER SURROUNDING CITY CENTER**
  - DISSYMMETRY BETWEEN BOTH LEFT & RIGHT BANKS
  - URBAN WATERFRONT AT THE FLOODPLAIN (RIVER DELTA)
- **HIGHLY ANTHROPIZED ENVIRONMENT**
  - EXTREMELY OPTIMIZED WATER SUPPLY: URBAN USES, AGRICULTURE
  - COMPLEX WEIR & IRRIGATION CANAL NETWORK
  - URBAN STREAM HISTORICALLY CHANNELLED
  - SEVERAL FLOW OBSTRUCTIONS

Source: SHYCEA

Source: Facebook

URBAN FLASH-FLOOD 13-14TH OCTOBER 1957.

CHARACTERISTICS

- **FAST-RESPONSE**
  - PREVIOUS RAINFALL
  - ACCUMULATED PRECIPITATION (MIDDLE BASIN)
  - SPASMODIC FLOOD WAVE

  DIRECT RUNOFF OVER 350 MM IN 4 HOURS ASCENDING BRANCH

- **FACTS**
  - HIGH WATER DISCHARGE
  - REMARKABLE BEDLOAD SEDIMENT TRANSPORT
  - FLOOD ESTIMATED AREA

  BIGGEST EPISODE EVER REGISTERED 370,000 m^3 MUD AT THE CITY AROUND 30 Km^2

- **DIFFICULTY OF THE URBAN FLOODING ANALYSIS**
  - HYDRAULIC COMPLEXITY
  - CLEANING UP & RESTORATION DELETED THE FLOOD MARKS

Source: ASINTO

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HYDROGRAPH ESTIMATION

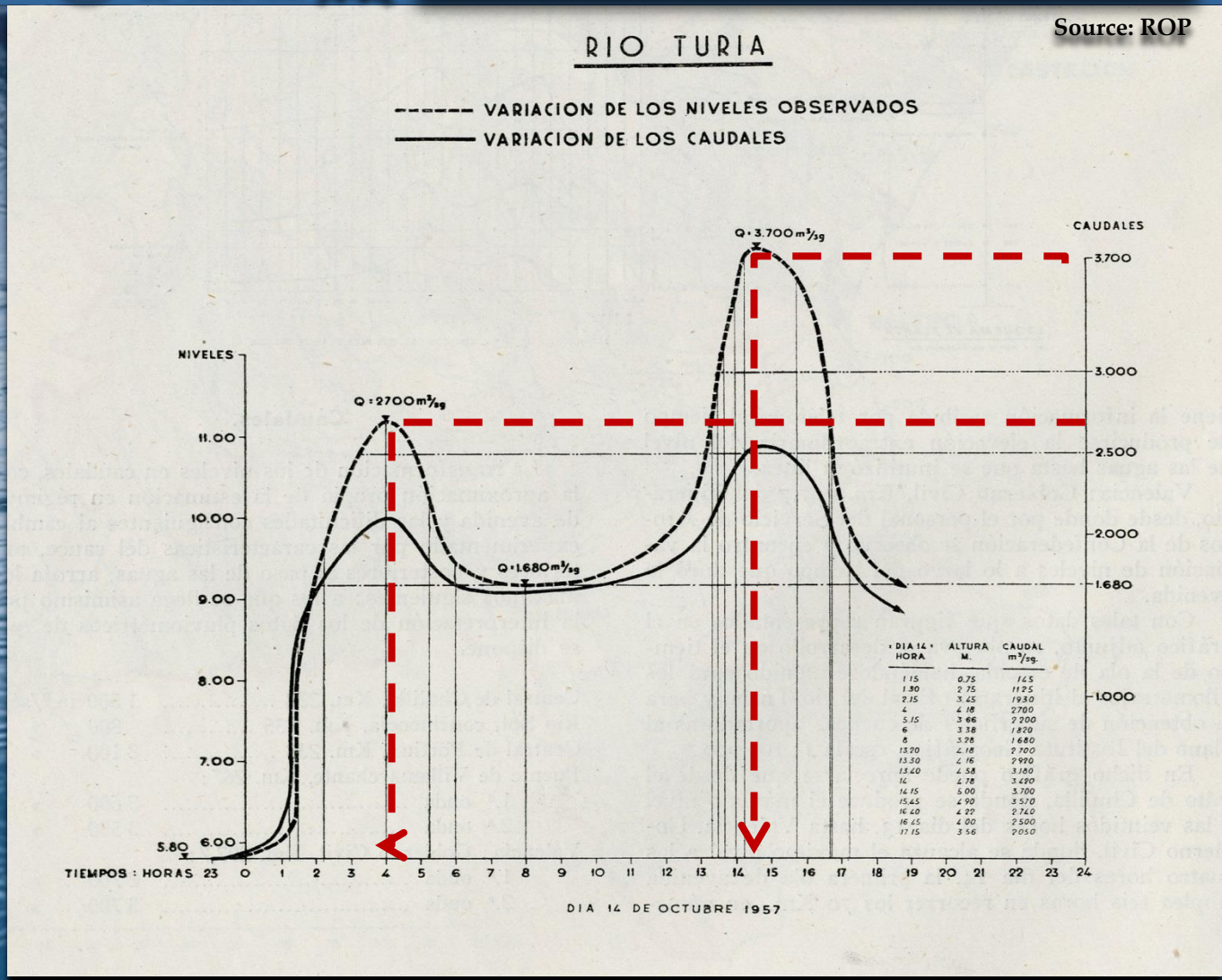
MAIN RIVER CHANNEL (CÁNOVAS 1958):

Q 1ST PEAK = 2,500 M³/S

Q 2ND PEAK = 3,700 M³/S

Source: Ibáñez

Source: ROP



Source: Las Provincias

URBAN FLASH-FLOOD 13-14TH OCTOBER 1957. RECONSTRUCTION

- **USUAL MATHEMATICAL HYDRAULIC MODELLING BECOMES COMPLEX**
  - DEALING WITH HISTORICAL FLASH-FLOOD (RESEARCHING 60 YEARS LATER)
  - DATA TYPOLOGY: NON-SYSTEMATIC INFORMATION
  - RECONSTRUCTION WITHIN A CITY THAT SUFFERED A METAMORPHOSIS
    - TOPOGRAPHIC CHANGES
      - STREET LEVEL
      - LEVEE HEIGHT
      - RIVERBED (ROUGHNESS & INVERT)
      - RIVER DIVERSION (SOUTH SOLUTION)
    - BOUNDARY CONDITIONS
- **G.I.S.-BASED MODEL AS ALTERNATIVE**
  - IMPLIES AN ENHANCEMENT METHOD (MODELLING UNMANAGEABLE OTHERWISE)
  - ENTAILS AN EXTRA SUPPORT TO THE VALIDATION & CALIBRATION EFFORT

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Source: AGJH

G.I.S.-BASED MODEL

GOALS

- COMPILING & STRUCTURING A VAST AMOUNT OF DIFFERENT INFORMATION SOURCES
- JOINT TREATMENT FROM A NEW PERSPECTIVE -> FRAMEWORK

FLOOD-G.I.S. DATABASE CONTENTS

- NON-SYSTEMATIC INFORMATION SPECIFIC VALUE
  - ADMINISTRATIVE CLAIM FILES FOR COMPENSATION (OVER 6,000)
  - GRAPHICAL DOCUMENTATION:
    - ✓ HIGH RESOLUTION ORTHOPHOTOS
    - ✓ PRIVATE AND ARCHIVE PHOTOGRAPHS
  - HYDRAULIC:
    - ✓ WATERMARKS
    - ✓ WATER LEVEL MILESTONES
- REINFORCEMENT INFORMATION
  - CANAL IRRIGATION NETWORK
  - URBAN RELIEF

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Title	Date	Scale
Valencia's Flood Mosaic	16 October 1957	1:5.000 & 1:6.500
Turia's Route	November? December? 1957	1:5.000 & 1:10.000
Aerial Photographs (Map Sheets 696 & 722 from MTN)	November December 1957	1:10.000
Valencia & Surroundings Photomap	1958	1:4.000 & 1:10.000
Metropolitan Ring Aerial Photographs	1958	1:7.500

G.I.S.-BASED MODEL.
DEALING WITH DATA

Source: SHYCEA

- **PHOTOINTERPRETATION OF PROCESSES**
  - **HYDRO-GEOMORPHIC**
    - COASTAL BARRIER TRENCHES
    - EROSION & DEPOSITION
    - INTERFLUVIAL DRAINAGE & PALEOCHANNELS
    - ALLUVIAL FAN & FLUVIAL TERRACES
    - RETURN FLOWS
  - **FLOW OBSTRUCTION ELEMENTS**
    - DEFLECTORS & ACCESS RAMPS
    - MEDIEVAL & MODERN BRIDGES
    - WEIRS & DIKES
    - HUMAN ACTIVITIES
  - **HYDRAULIC**
    - MAIN CHANNEL FLOW
    - QUASI-STATIC FLOW
    - FLOODING THRESHOLDS
    - 2ND FLOWS DIRECTIONAL INFORMATION
    - ONE-DIMENSIONAL & TWO-DIMENSIONAL BEHAVIOUR
    - WATERLEVELS & FLOODED POINTS
  - **DAMAGE TO REFERRED INFRASTRUCTURES**
- **ALLOWING**
  - ACQUIRING A GLOBAL VIEW
  - GEOREFERENCING N.S.I. ABOUT SPATIAL VARIABILITY
  - CARTOGRAPHY ELABORATION

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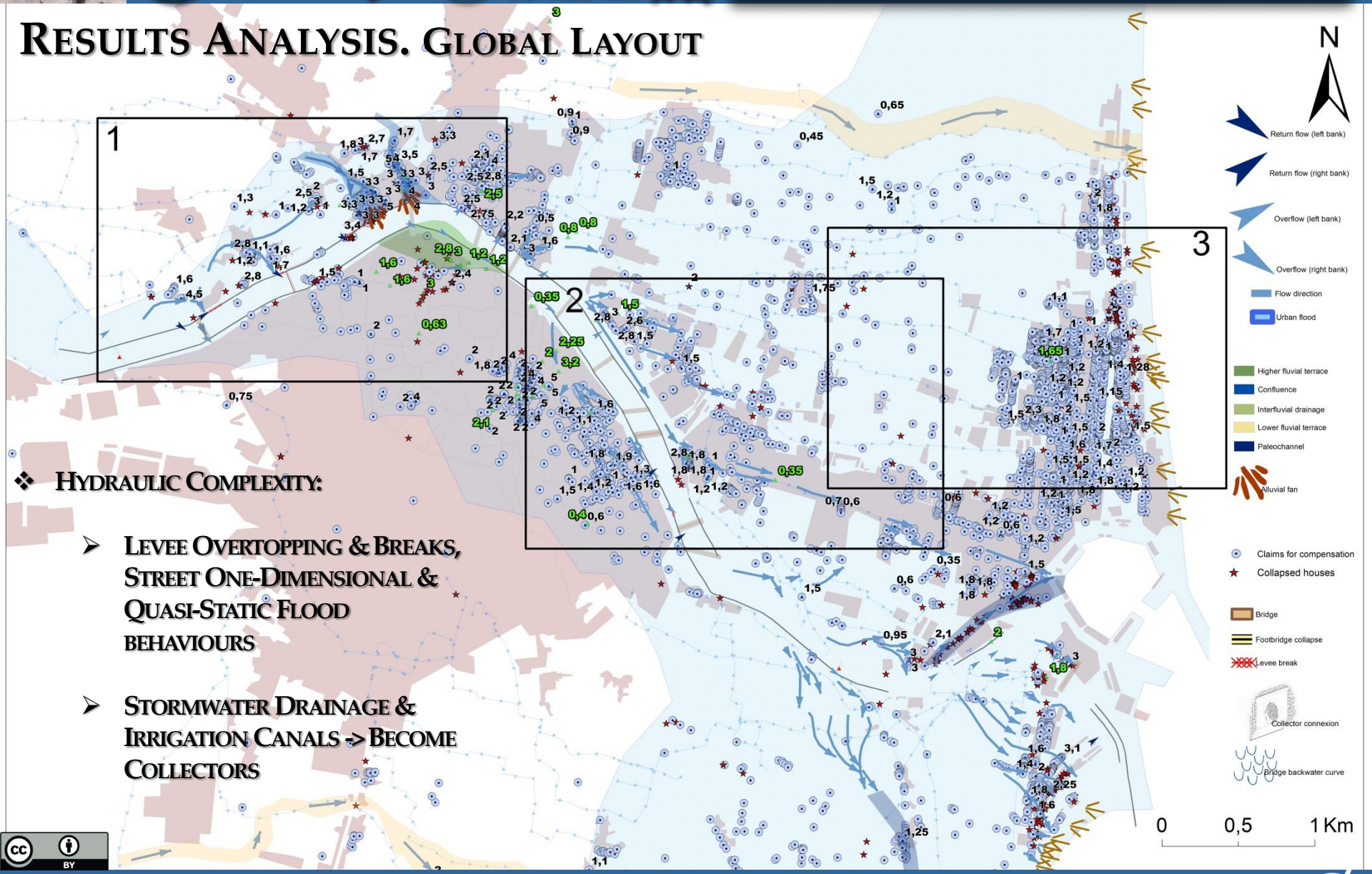
RESULTS ANALYSIS. GLOBAL LAYOUT



- **HYDRAULIC COMPLEXITY:**
  - **LEVEE OVERTOPPING & BREAKS, STREET ONE-DIMENSIONAL & QUASI-STATIC FLOOD BEHAVIOURS**
  - **STORMWATER DRAINAGE & IRRIGATION CANALS -> BECOME COLLECTORS**

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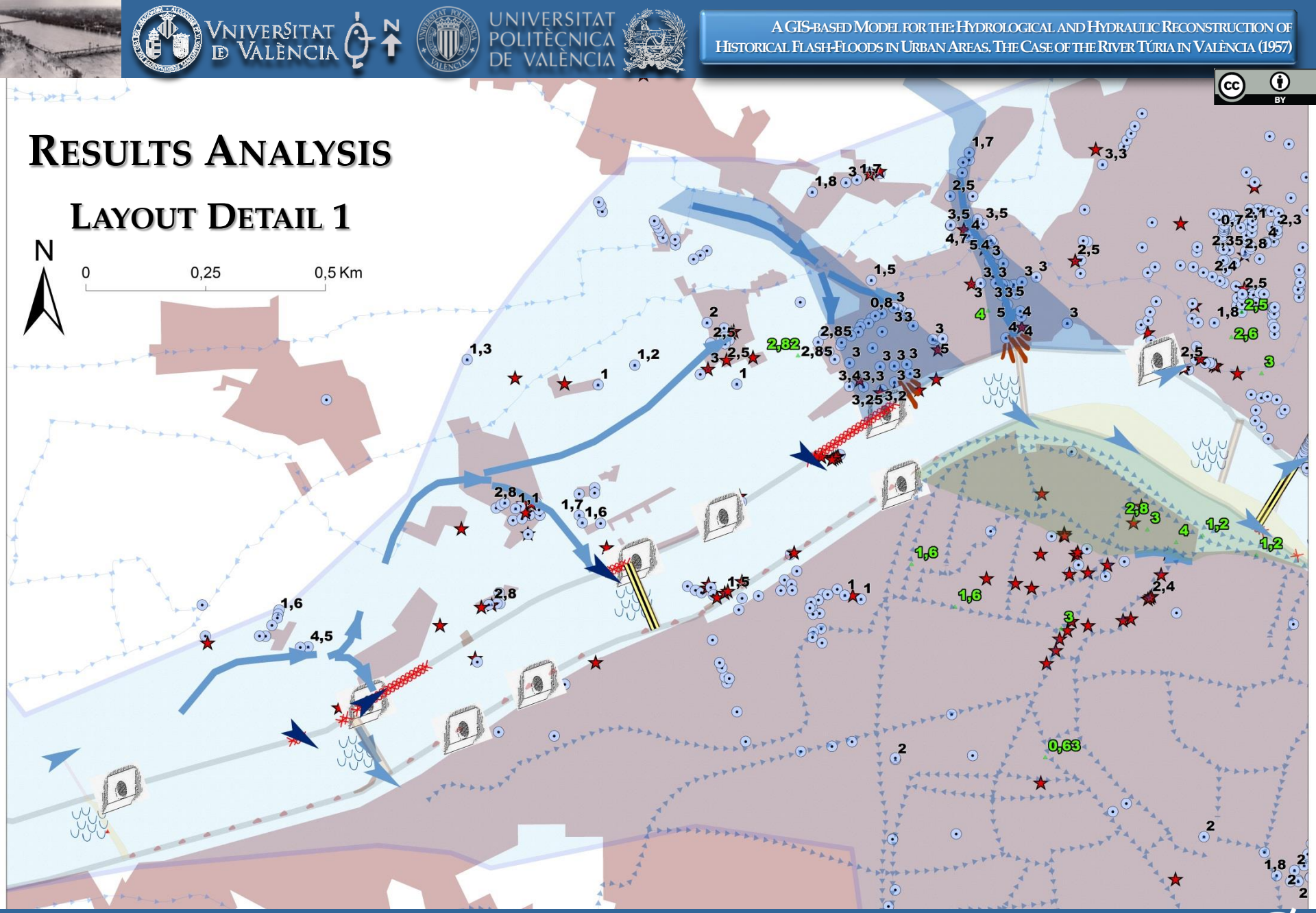
RESULTS ANALYSIS

LAYOUT DETAIL 1



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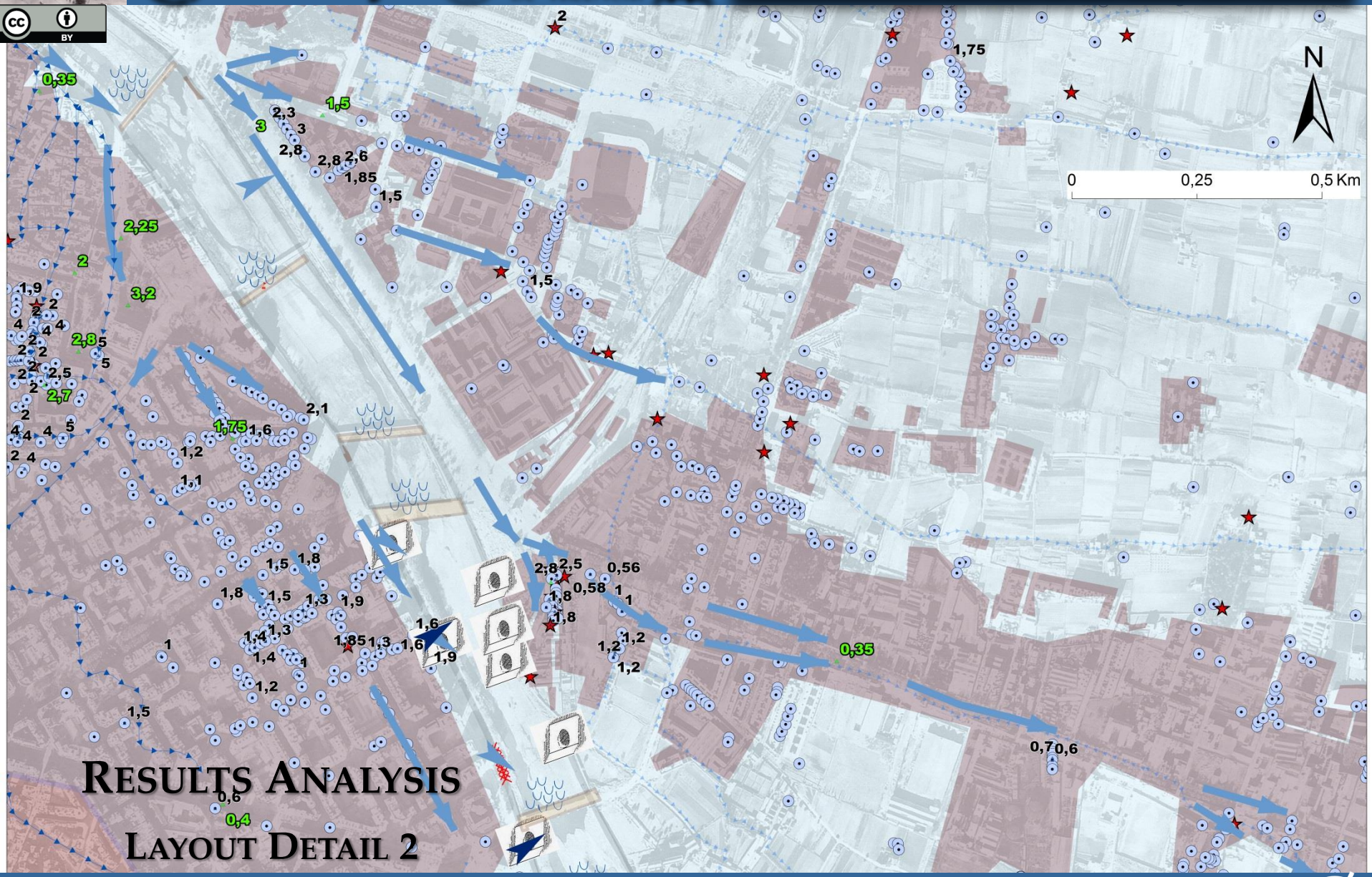
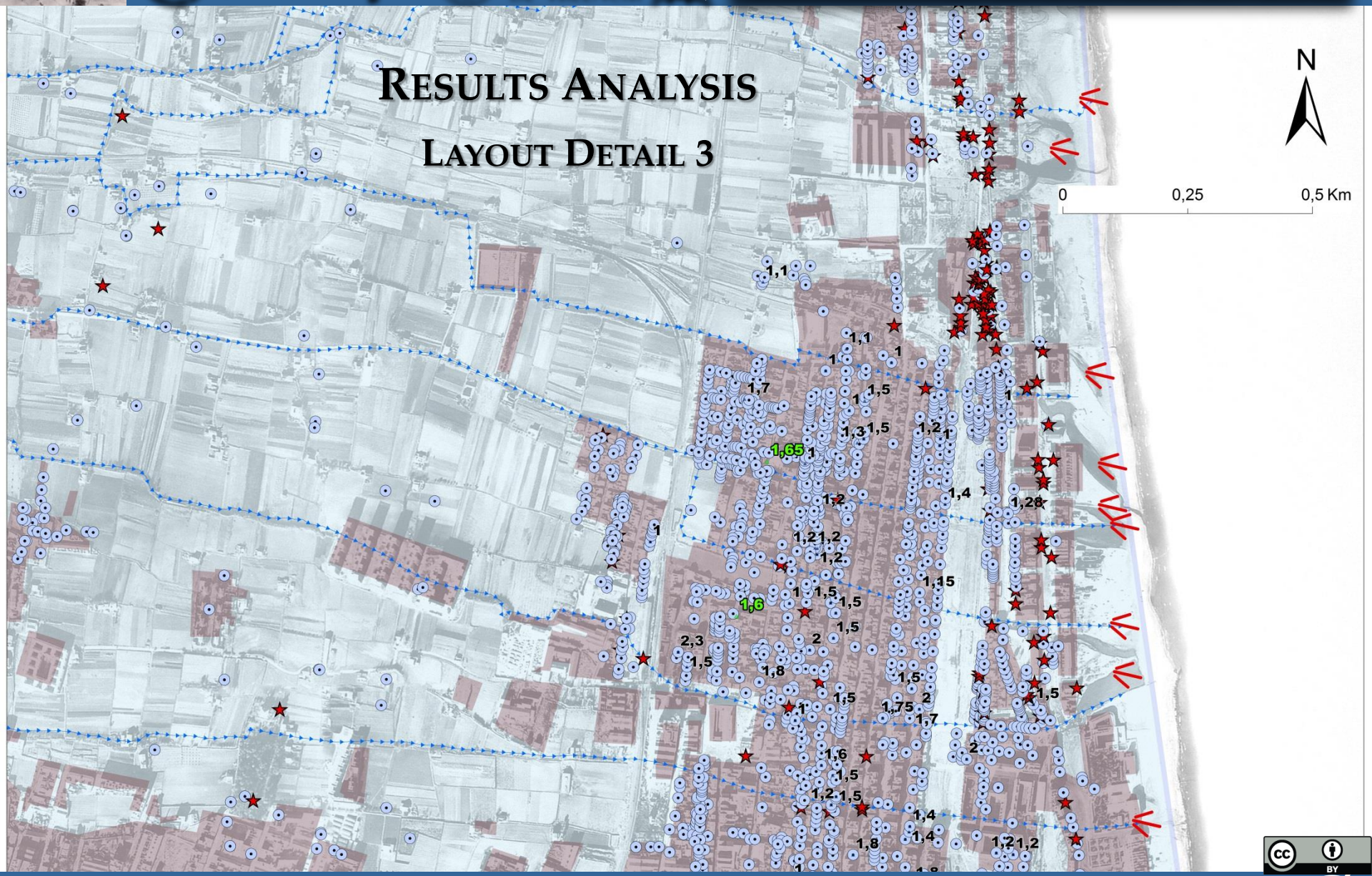


RESULTS ANALYSIS

LAYOUT DETAIL 2

RESULTS ANALYSIS

LAYOUT DETAIL 3



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G.I.S.-BASED MODEL DESCRIPTION. CONCLUSIONS

GLOBAL

- URBAN FLASH-FLOOD WITH CHARACTERISTIC SPECIFICATIONS REQUIRES CUSTOMIZED NON USUAL MODELLING METHOD
- G.I.S.-BASED MODEL POTENTIAL
  - FLOOD-G.I.S. DATABASE
  - FLOOD HYDRAULIC SCHEME BEHAVIOUR CONCEPTUALIZATION
  - MATHEMATICAL MODELLING SUPPORT
  - CALIBRATION & VALIDATION

PARTICULAR

- JOURNEY TO THE 1957 URBAN FLASH-FLOOD
- DATABASE WILL ENABLE TO OBTAIN MORE ACCURATE RECONSTRUCTION
- PROVIDES DATA FOR FLOOD FREQUENCY ANALYSIS

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THANKS FOR YOUR ATTENTION

PHOTO ARCHIVES INDEX

AGJH: ARCHIVO GRÁFICO JOSÉ HUGUET
AHMV: ARCHIVO HISTÓRICO MUNICIPAL DE VALENCIA
ENRIQUE IBÁÑEZ'S ARCHIVE
FACEBOOK: FACEBOOK.COM/VALENCIA ANTIGUA: HISTORIA GRÁFICA LAS PROVINCIAS
ROP: REVISTA DE OBRAS PÚBLICAS (1958)
SHYCEA: SERVICIO HISTÓRICO Y CULTURAL DEL EJÉRCITO DEL AIRE

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QUESTIONS

European Geosciences Union
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