

# G F P

global flood partnership

## Quantitative impact-based multi-model Early Warning System

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FONDAZIONE CIMA  
CIMA RESEARCH FOUNDATION

CENTRO INTERNAZIONALE IN MONITORAGGIO AMBIENTALE  
INTERNATIONAL CENTRE ON ENVIRONMENTAL MONITORING

# The Challenge

EWS is one of the most effective mitigation action against floods.

Its **effectiveness** depends on:

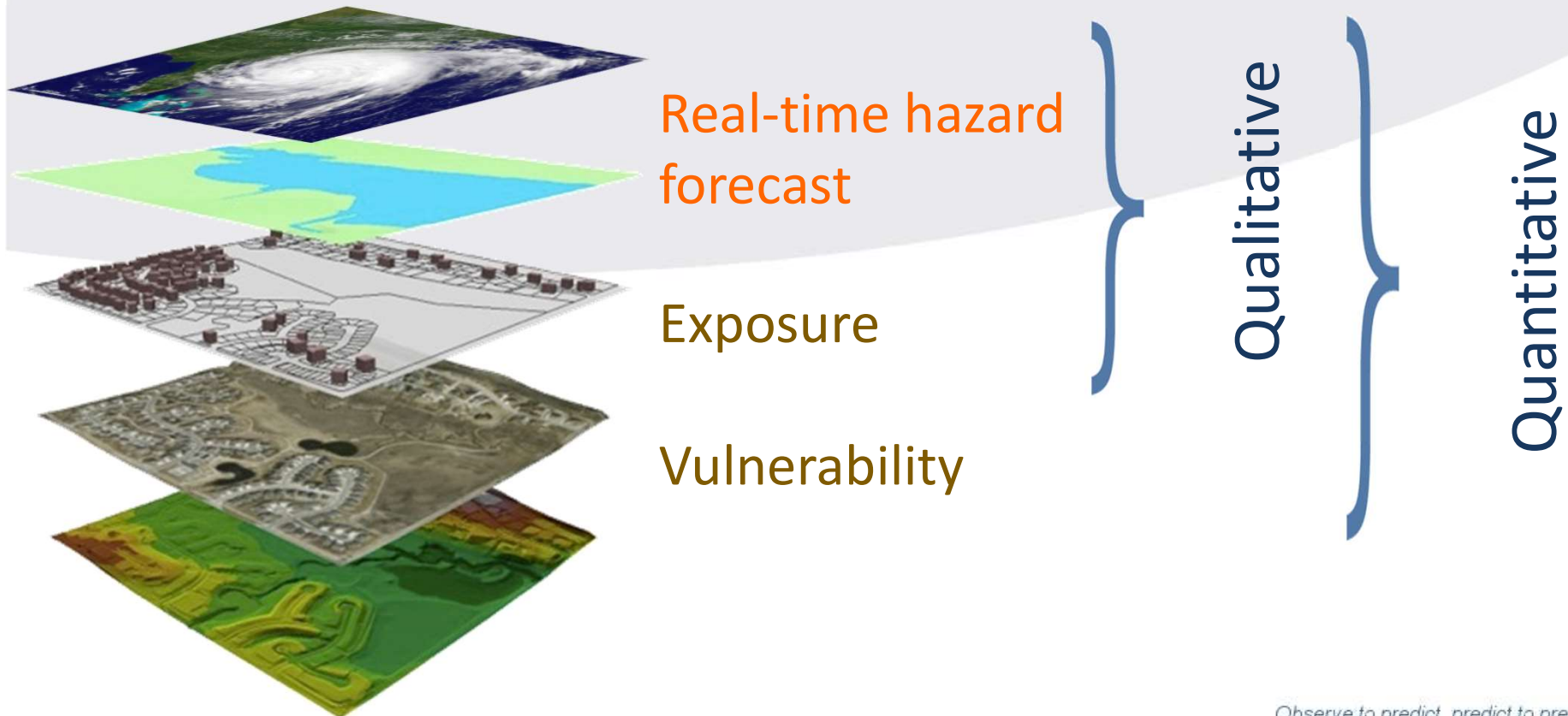
- The **accuracy and precision** of the forecast parameters
- Because of its uncertain nature, on a objective **cost-benefit analysis** to activate planned action in case of a feared event.

# The Challenge

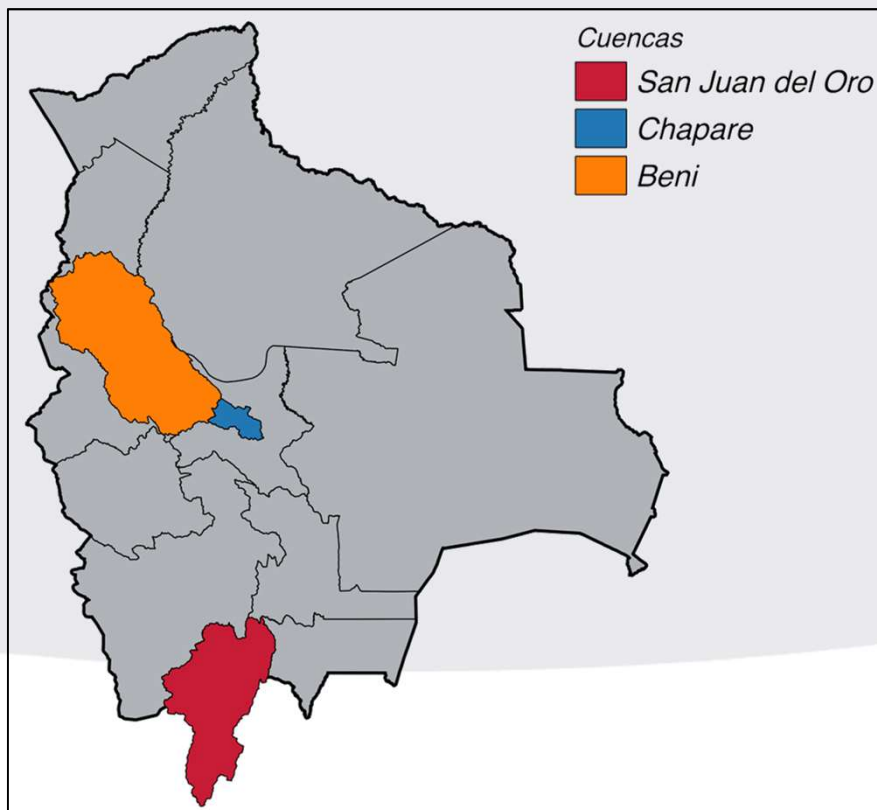
- Have a proper **quantification of uncertainty**
- **Build the capacity of the EWS to forecast quantitative impact scenarios**, to enable the decision maker to take prevention actions based on impact forecast.

It is necessary to go from qualitative to quantitative impact forecast

$$\text{Impact} = f(H, E, V, A)$$



# Implementation in Bolivia

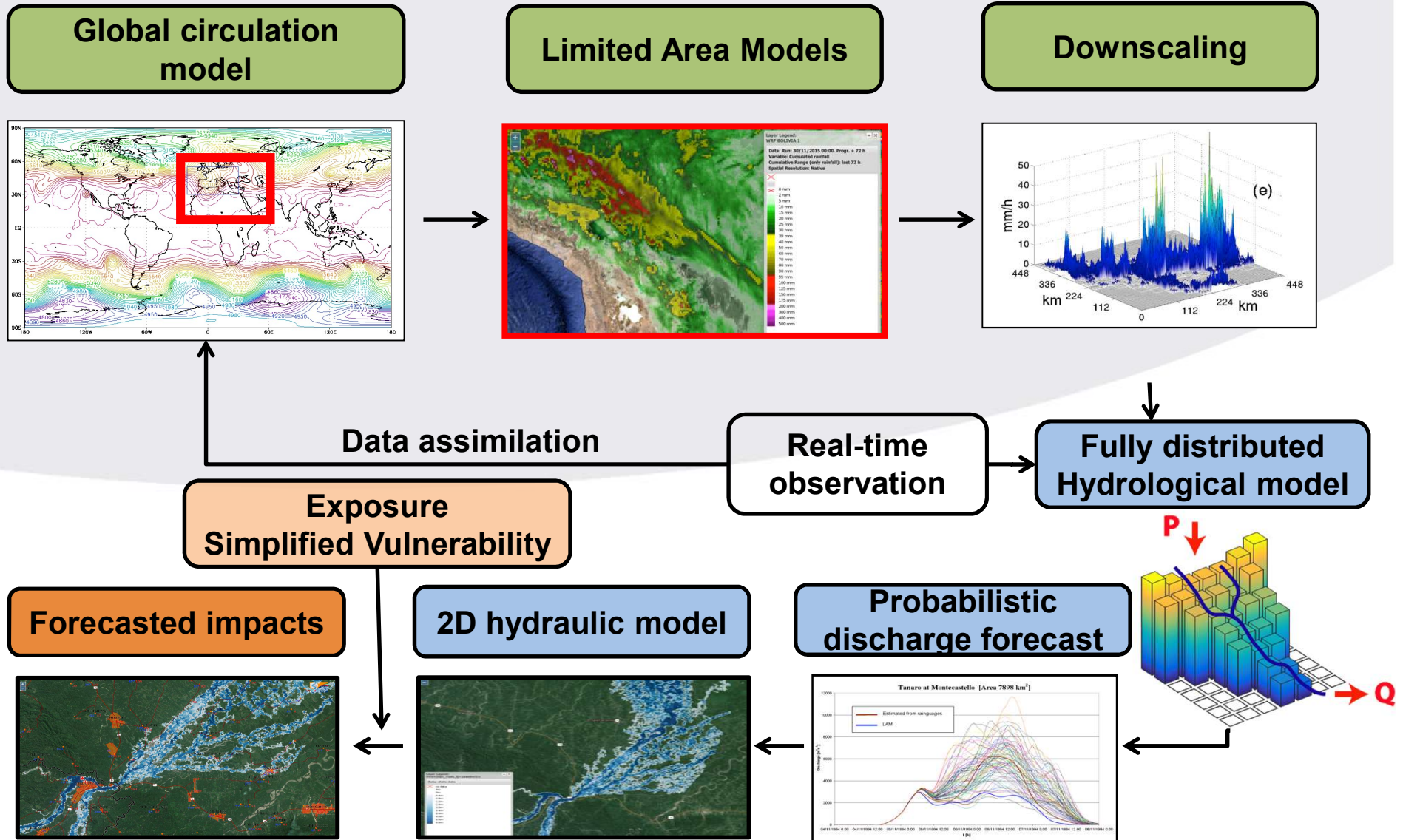


- Río **Chapare** (Cochabamba)  
5'000 km<sup>2</sup>
- Río **San Juan del Oro** (Potosí)  
45'000 km<sup>2</sup>
- Río **Beni** (La Paz)  
70'000 km<sup>2</sup>



AGENZIA ITALIANA  
PER LA COOPERAZIONE  
ALLO SVILUPPO

# Impact-based flood forecasting chain

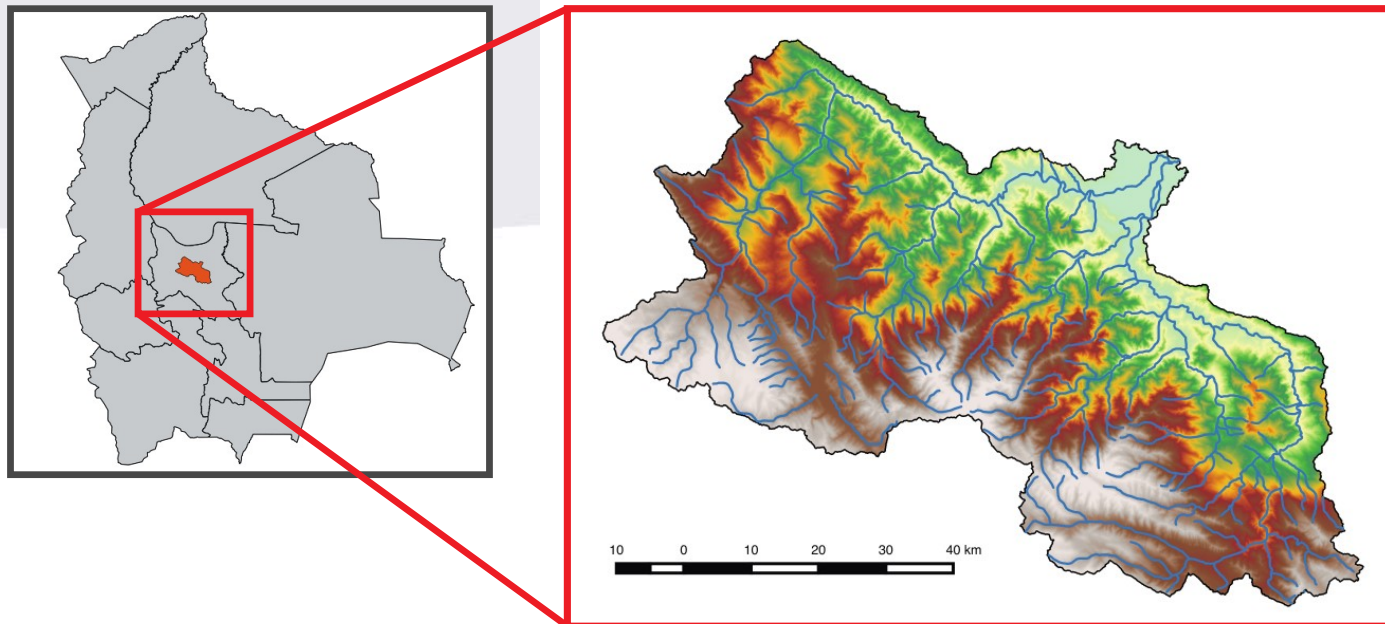


Observe to predict, predict to prevent

# Chapare river basin in Bolivia

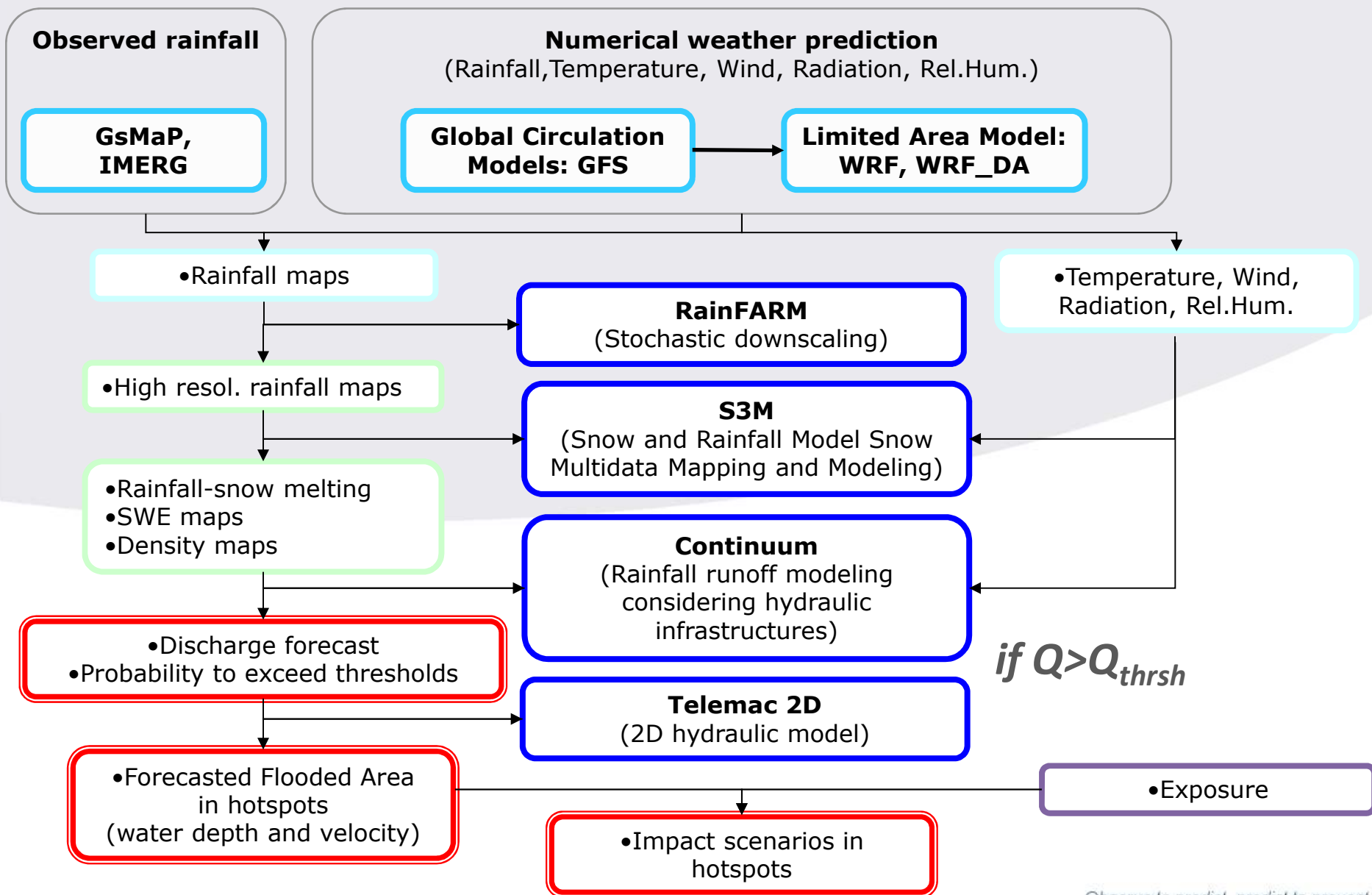
Two main tributaries (Espiritu Santo and San Mateo) that join together in correspondence of the city of Villa Tunari (56'000 inhabitants)

Basin Area	5000 km <sup>2</sup>
Maximum Elevation	5000 m amsl
Minimum Elevation	280 m amsl



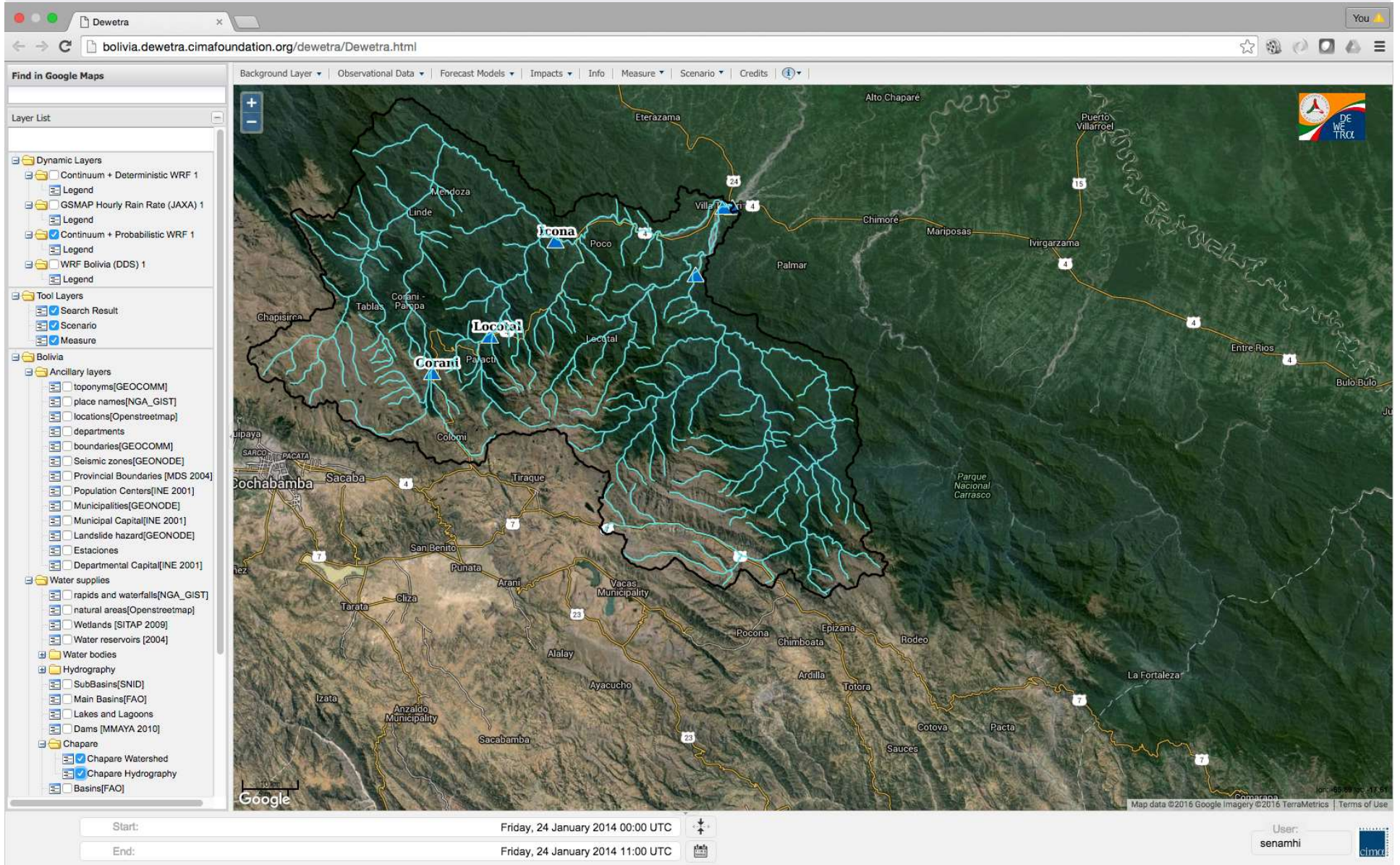
Relatively small catchment, one of the most rainy area of Bolivia

# Impact modelling chain

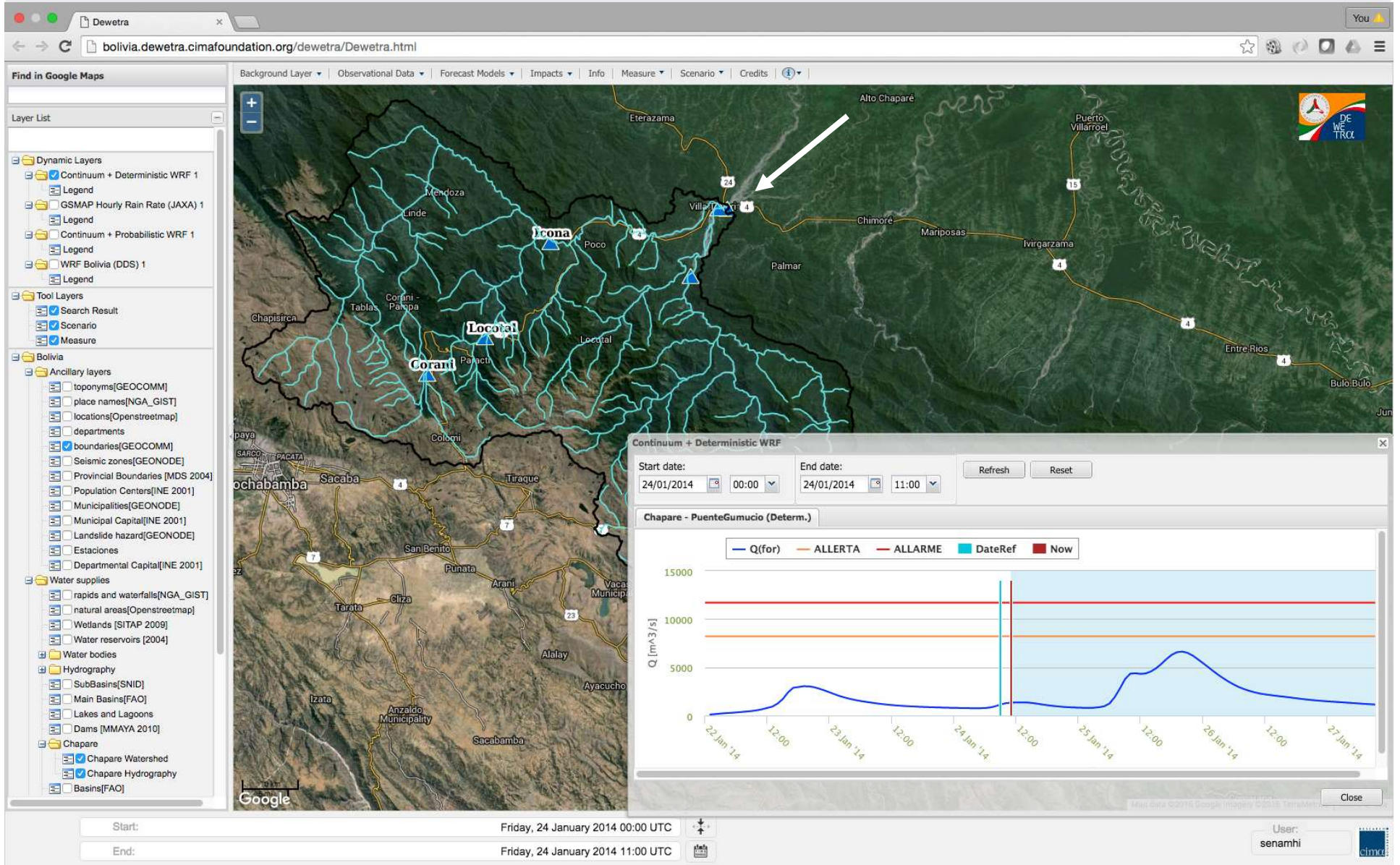




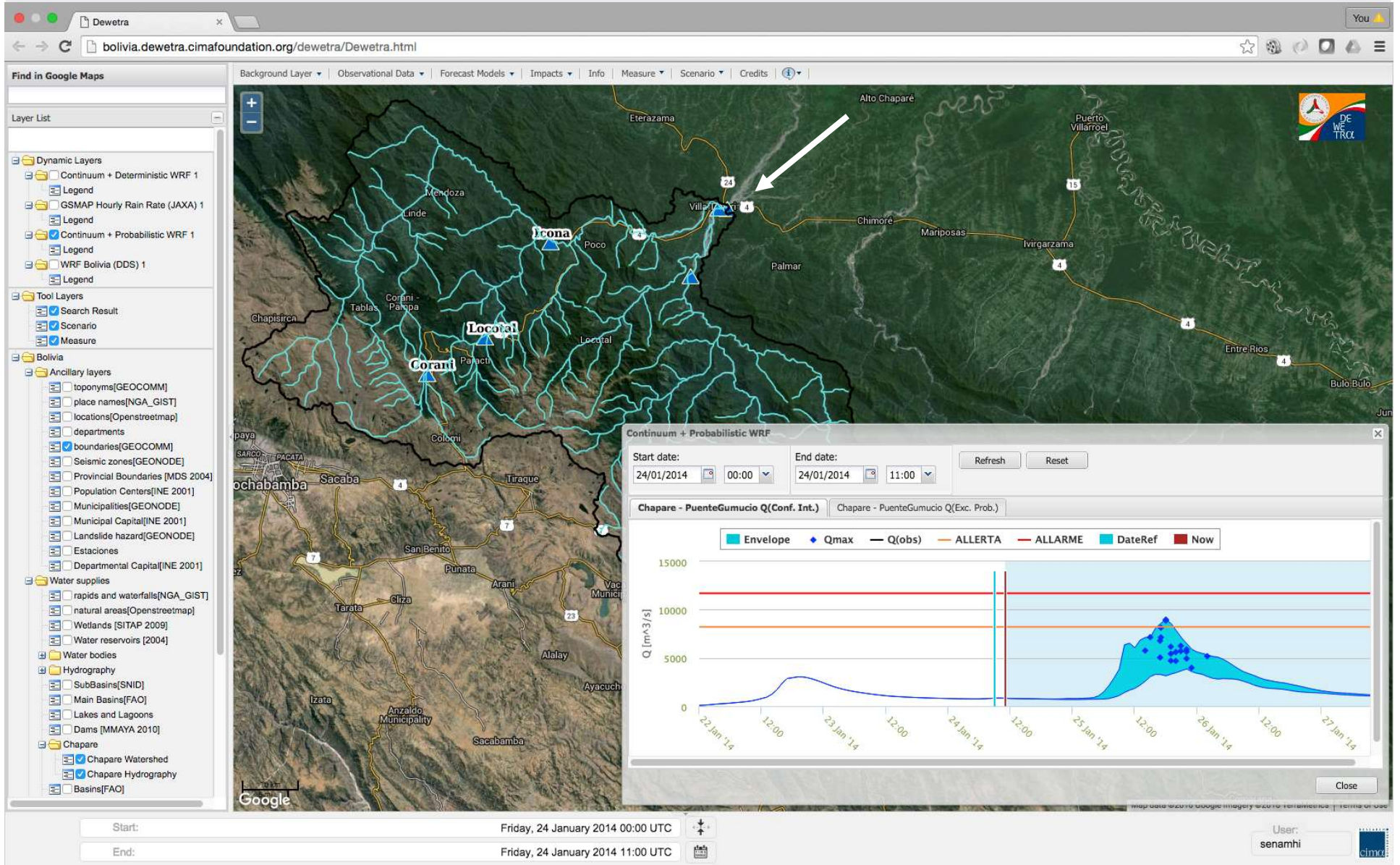
# Probabilistic discharge forecasts



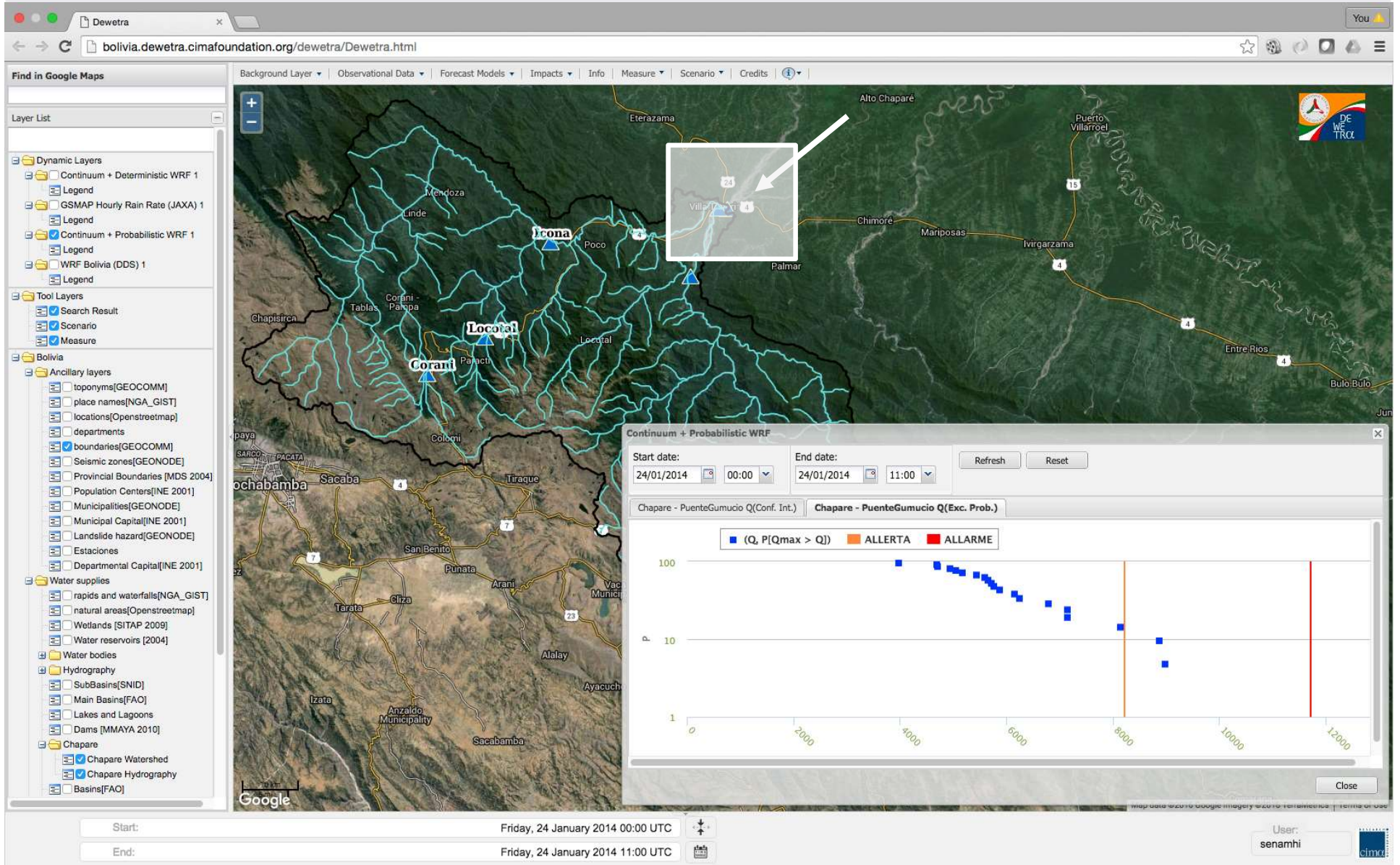
# Probabilistic discharge forecasts



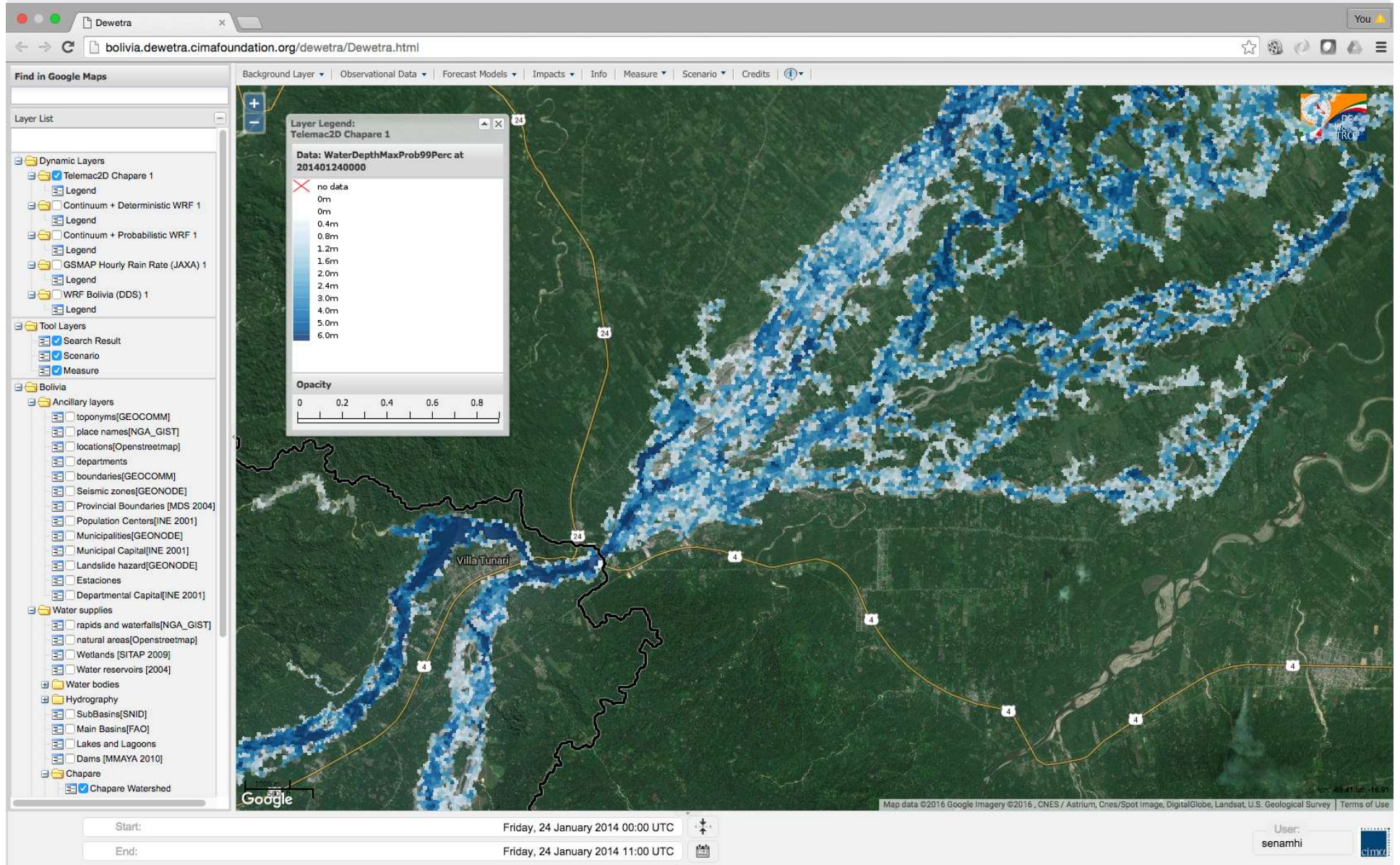
# Probabilistic discharge forecasts



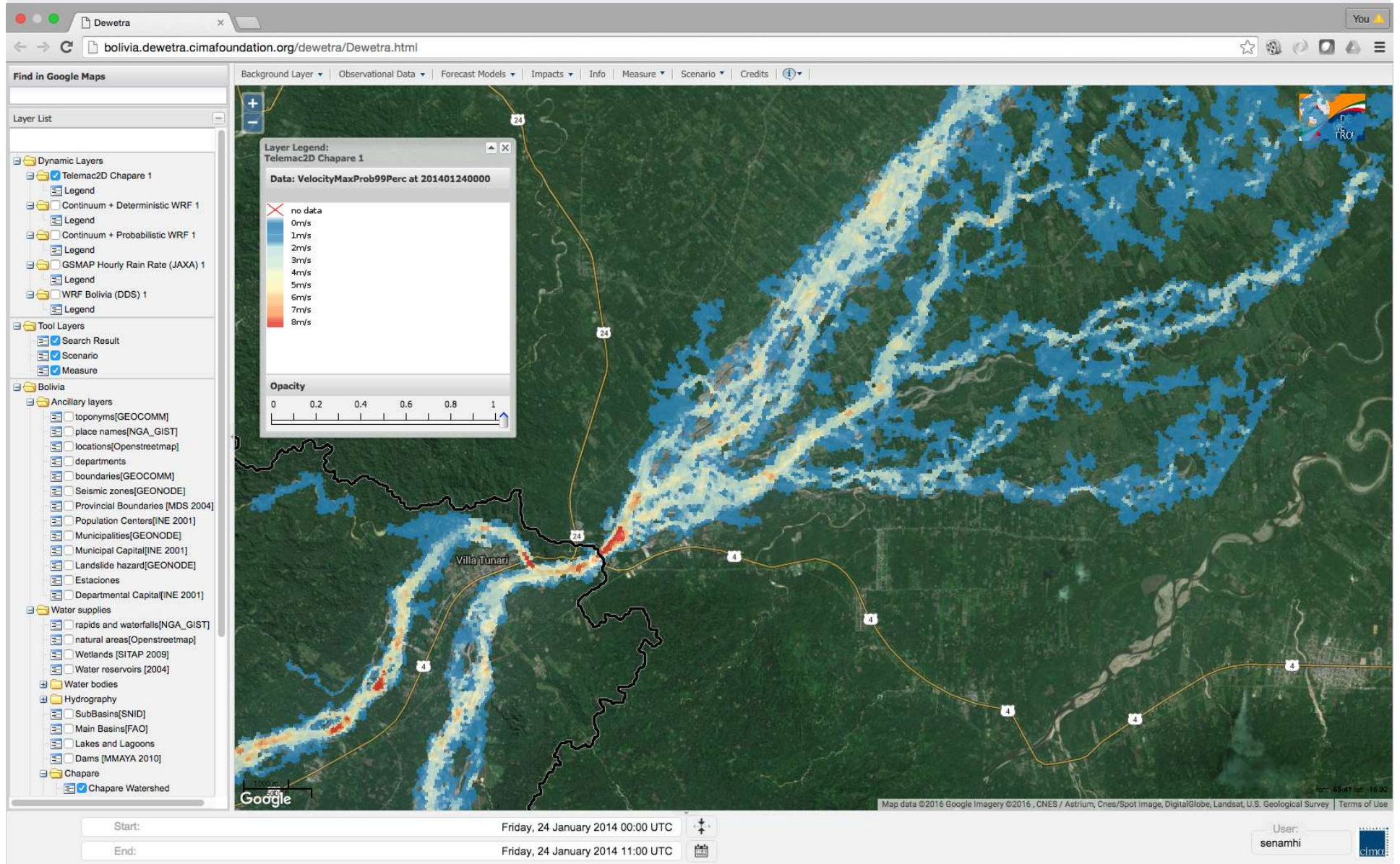
# Probabilistic discharge forecasts



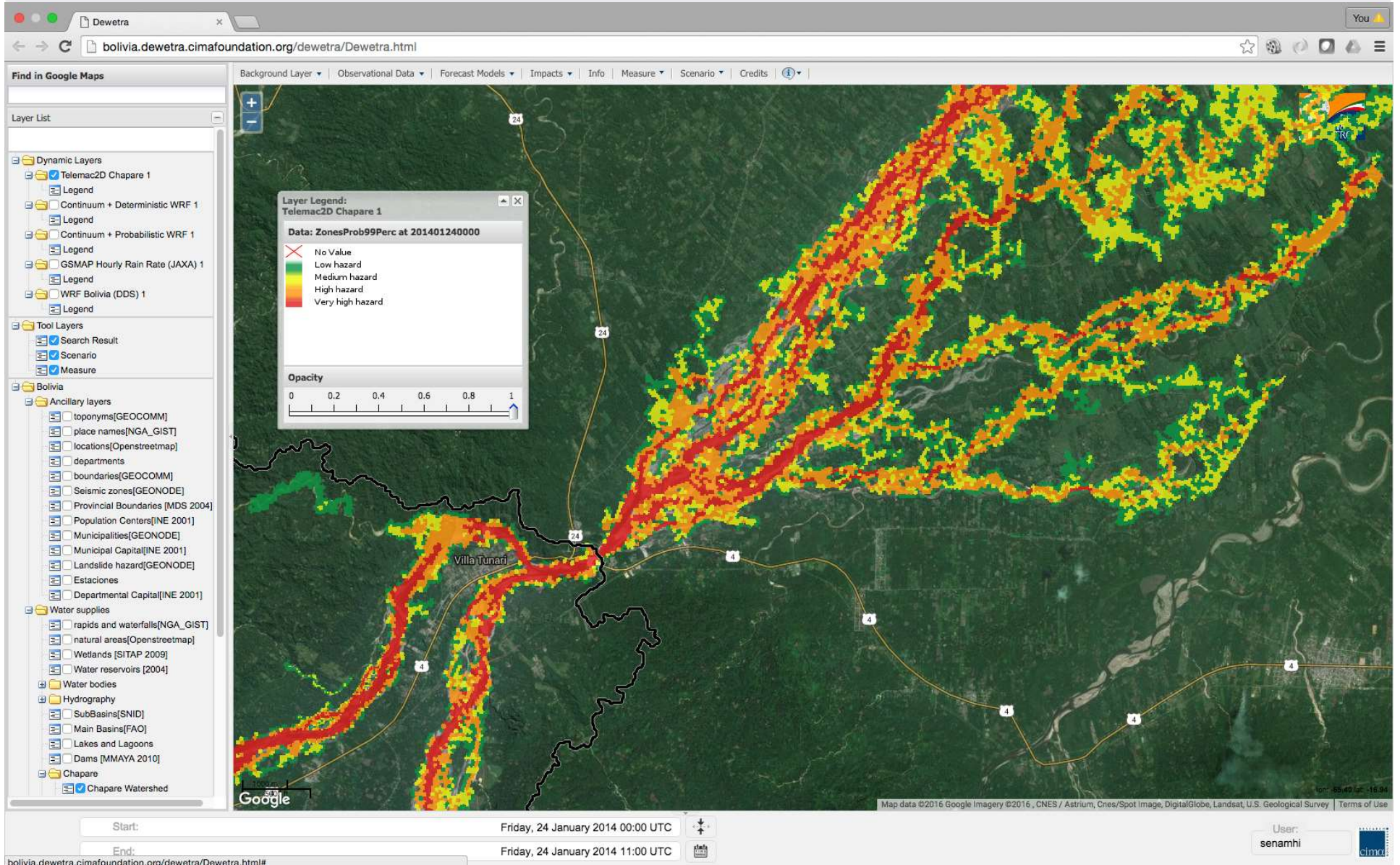
# Flood scenarios on hotspots: water depth



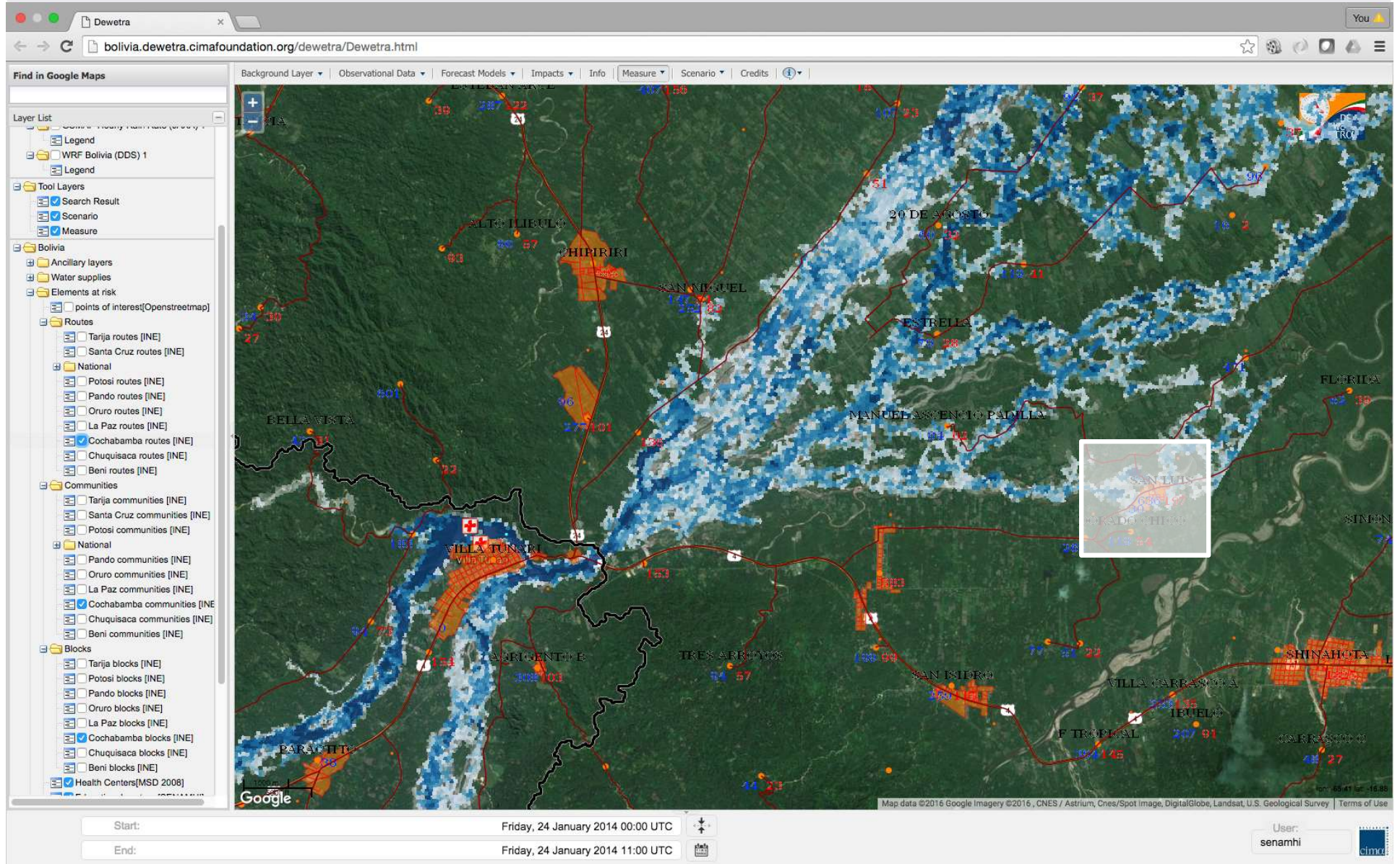
# Flood scenarios on hotspots: velocity



# Flood scenarios on hotspots: hazard zones



# Impact scenarios on hotspots: hazard + assets at risk





# Impact scenarios on hotspots

The screenshot shows the Dewetra web application interface. The main map displays a satellite view of a region in Bolivia with various impact scenarios overlaid in different colors (blue, yellow, red). A 'Scenario Layers Filter' dialog box is open, showing a table of community data. The 'poblacion' and 'viviendas' columns are circled in red.

**Scenario Layers Filter**

uncheck all

Comunidades

Points of interest (Open street map)

Basins level 5 (MMAYA)

Educational centers (MDS 2004)

Municipal capital (INE 2001)

Search

Comunidades					
poblacion	municipio	gid	departamen	viviendas	id_uni
636	Shinaota	20263	COCHABAMB	197	56036

Export Close

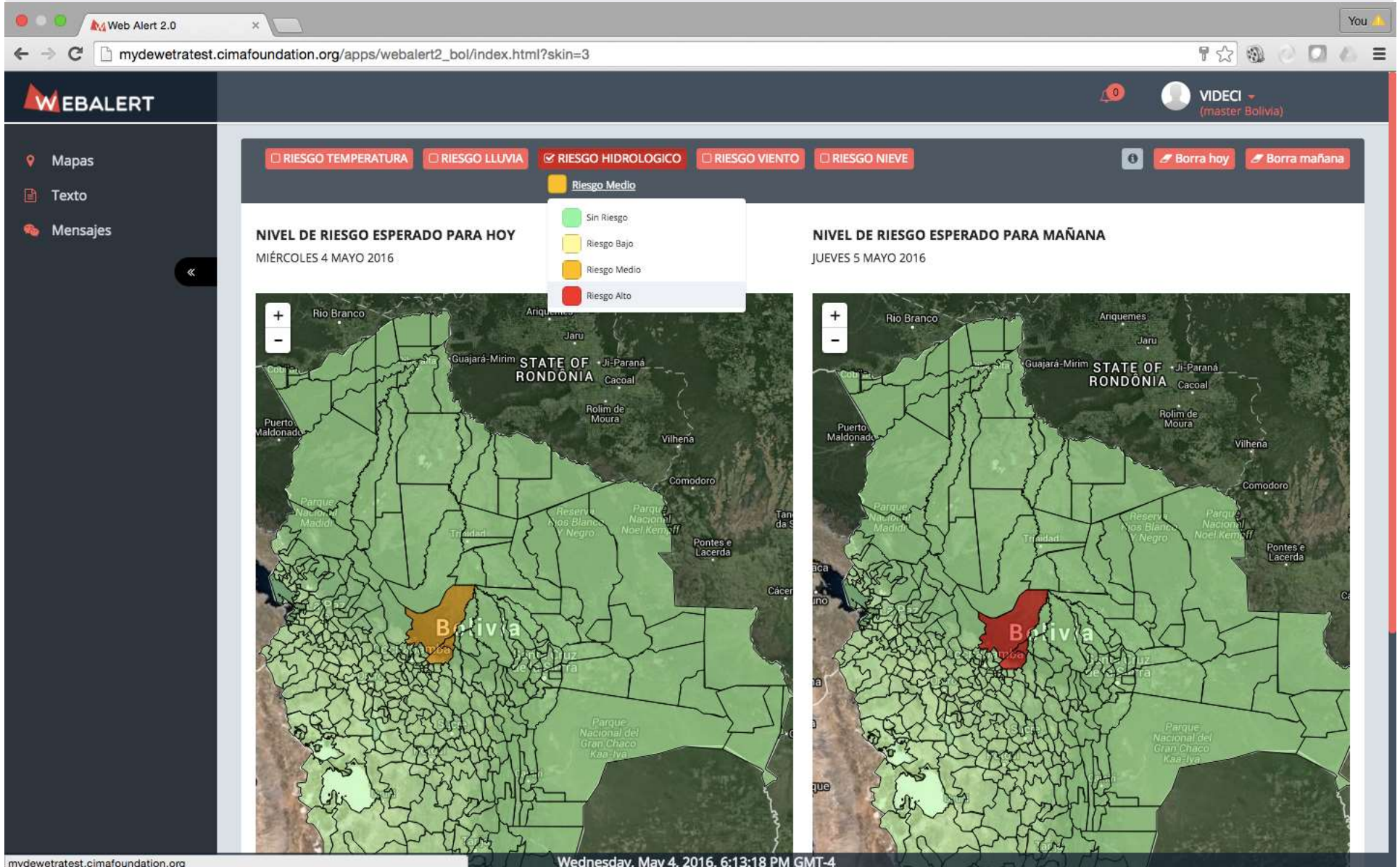
Start: Friday, 24 January 2014 00:00 UTC

End: Friday, 24 January 2014 11:00 UTC

User: senamhi

Map data ©2016 Google Imagery ©2016 CNES / Astrium, Cnes/Spot Image, DigitalGlobe | Terms of Use

# Impact-based multi-hazard bulletin preparation



# Impact-based multi-hazard bulletin preparation

The screenshot displays the WEBALERT web application interface, which is used for preparing impact-based multi-hazard bulletins. The interface is divided into a left sidebar and a main content area.

**Left Sidebar:** Contains navigation options: **Mapas**, **Texto**, and **Mensajes**.

**Main Content Area:**

- GESTION BOLETIN:** Includes buttons for **Nuevo**, **Actualiza**, and **Erratas**.
- OBJETO: BOLETIN DE RIESGO NACIONAL:** Contains a reference to Ley 602, Art. 37 y 38, and Ley 031, Art. 100, regarding the responsibility of the Ministry of Defense for natural disaster risk management.
- CONSIDERADO QUE:** Lists conditions such as "no ha sido emitido el boletín de vigilancia meteorología nacional por el SENAMHI" and "no son presentes avisos de criticidad meteorológica".
- EL NUCLEO OPERATIVO CENTRAL DEL VICEMINISTERIO DE DEFENSA CIVIL:** States the bulletin is based on a meteorological vigilance bulletin issued by SENAMHI on May 4, 2016, at 13:00.
- EVALUA EL SIGUIENTE BOLETIN DE RIESGO NACIONAL:** This section is divided into two parts:
  - PER EL DIA DE HOY:** Lists risks for today: **RIESGO LLUVIA ALTO** (Cochabamba: Shinahota, Tiraque, Villa Tunari) and **RIESGO HIDROLOGICO MEDIO** (Cochabamba: Shinahota, Tiraque, Villa Tunari).
  - PER EL DIA DE MAÑANA:** Lists risks for tomorrow: **RIESGO HIDROLOGICO ALTO** (Cochabamba: Shinahota, Tiraque, Villa Tunari).
- NOTAS:** A section for additional notes, currently containing the text "Unidad de Prevención SNATD-SINAGER".

**Bottom Bar:** Includes a date and time stamp: "Wednesday, May 4, 2016, 6:14:14 PM GMT-4".

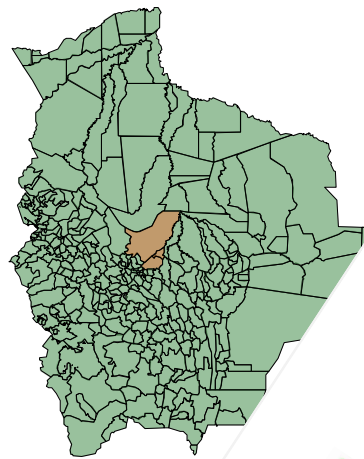
**Bottom Right:** Contains action buttons: **Vista Previa**, **Guarda y Publica**, **Exporta**, and a button labeled **Riesgo del Boletín** with the text **RIESGO HIDROLOGICO** below it.

# Impact-based multi-hazard bulletin



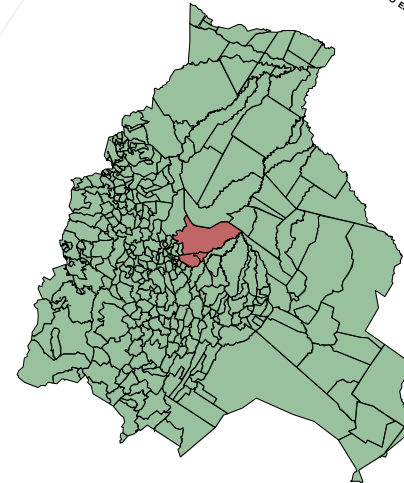
Ministerio de Defensa  
VICEMINISTERIO DE DEFENSA CIVIL

RIESGO HIDROLÓGICO - NIVEL DE RIESGO ESPERADO PARA MIÉRCOLES 4 MAYO 2016



Ministerio de Defensa  
VICEMINISTERIO DE DEFENSA CIVIL

RIESGO HIDROLÓGICO - NIVEL DE RIESGO ESPERADO PARA JUEVES 5 MAYO 2016



Ministerio de Defensa  
VICEMINISTERIO DE DEFENSA CIVIL

**OBJETO: BOLETÍN DE RIESGO NACIONAL.**

REF. LEY 602, ART 37 y 38 - RESPONSABILIDAD DEL MINISTERIO DE DEFENSA (CLASIFICACIÓN DE ALERTAS);  
LEY 1931, ART. 106 - (GESTIÓN DE RIESGOS Y ATENCIÓN DE DESASTRES NATURALES);  
LEY 1931, ART. 107 - (GESTIÓN DE RIESGOS Y ATENCIÓN DE DESASTRES NATURALES);  
D.S. 347, ART 42 - ALERTAS;  
D.S. 347, ART 42 - ALERTAS;  
AL DEFENSA INTELIGENTE A MINUTENARRADO EVENTO;  
D.S. 2988A, ART 14 - (ACCIONES DEL VICEMINISTERIO DE DEFENSA CIVIL PARA LA PREPARACIÓN, ALERTA, RESPUESTA, REHABILITACIÓN Y RECONSTRUCCIÓN EN CASO DE EMERGENCIAS Y DESASTRES NATURALES);  
D.S. 2988A, ART 14 - (ACCIONES DEL VICEMINISTERIO DE DEFENSA CIVIL PARA LA PREPARACIÓN, ALERTA, RESPUESTA, REHABILITACIÓN Y RECONSTRUCCIÓN EN CASO DE EMERGENCIAS Y DESASTRES NATURALES);

**CONSIDERADO QUE:**  
- ha sido emitido el boletín de vigilancia meteorológica nacional por el SENAMHI;  
- no son presentes áreas de ciudades meteorológicas;

**EL NÚCLEO OPERATIVO CENTRAL DEL VICEMINISTERIO DE DEFENSA CIVIL**  
Sobre la base del boletín de vigilancia meteorológica emitido por el SENAMHI el día de hoy a horas 13

**PER EL DÍA DE HOY, MIÉRCOLES 4 MAYO 2016**  
Cochabamba, Shishabamba, Tiraque, Villa Tunari

**PARA EL DÍA DE MAÑANA, JUEVES 5 MAYO 2016**  
Cochabamba, Shishabamba, Tiraque, Villa Tunari

**RIESGO HIDROLÓGICO ALTO**  
Cochabamba, Shishabamba, Tiraque, Villa Tunari  
MIÉRCOLES 4 MAYO 2016  
Hora 22:35  
Unidad de Prevención SNATD-SINAGER

# Impact-based forecast for livestock

## Exposure

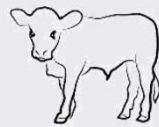
- Species
- Amount
- Localization
- Value



Exposure localization and value

## Vulnerability

- % pregnant
- % nursing
- % juvenile



Vulnerability index for each species

## Forecasted Hazard

- Flood
- Ground frost
- Heat wave
- Strong wind
- Heavy rainfall
- Drought
- Forest fires



Time and space of hazard

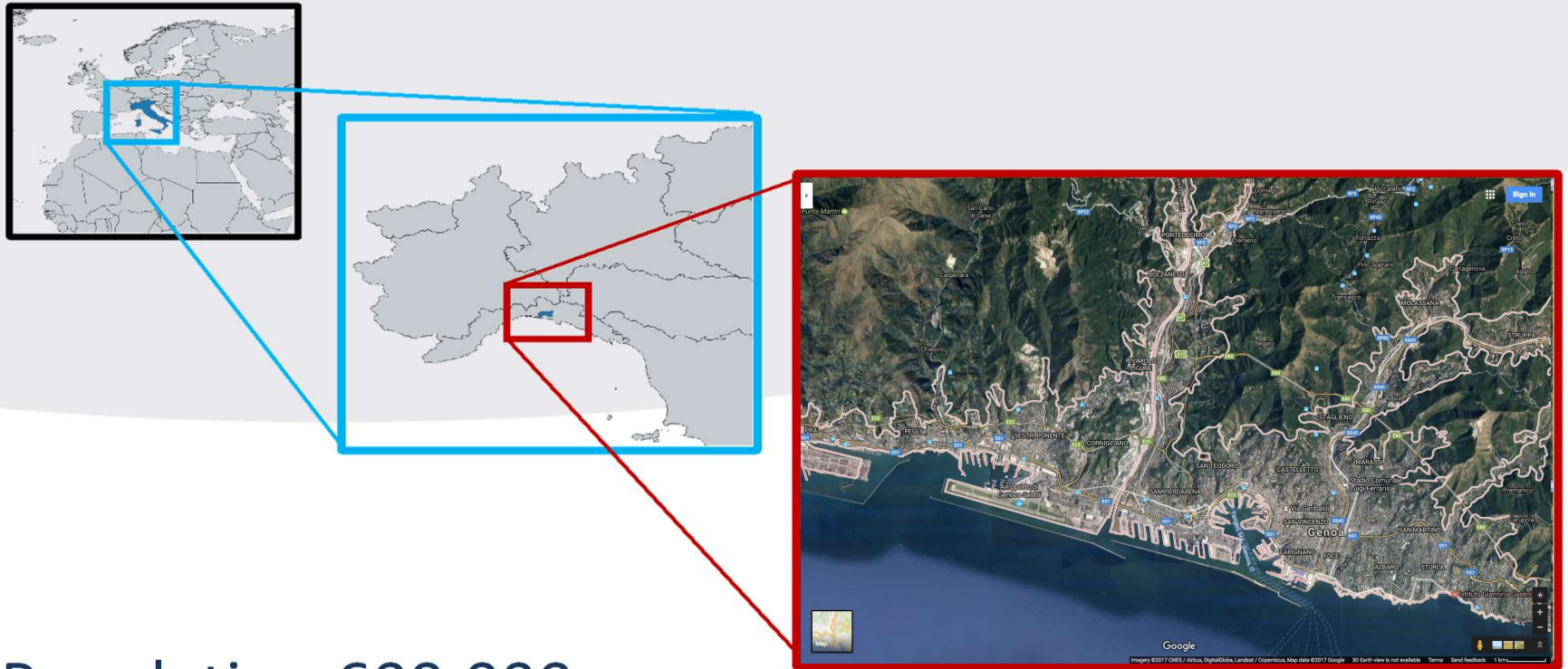
Impact scenario

# Informed actions to protect livestock



Livestock displacement onto a “loma ganadera”

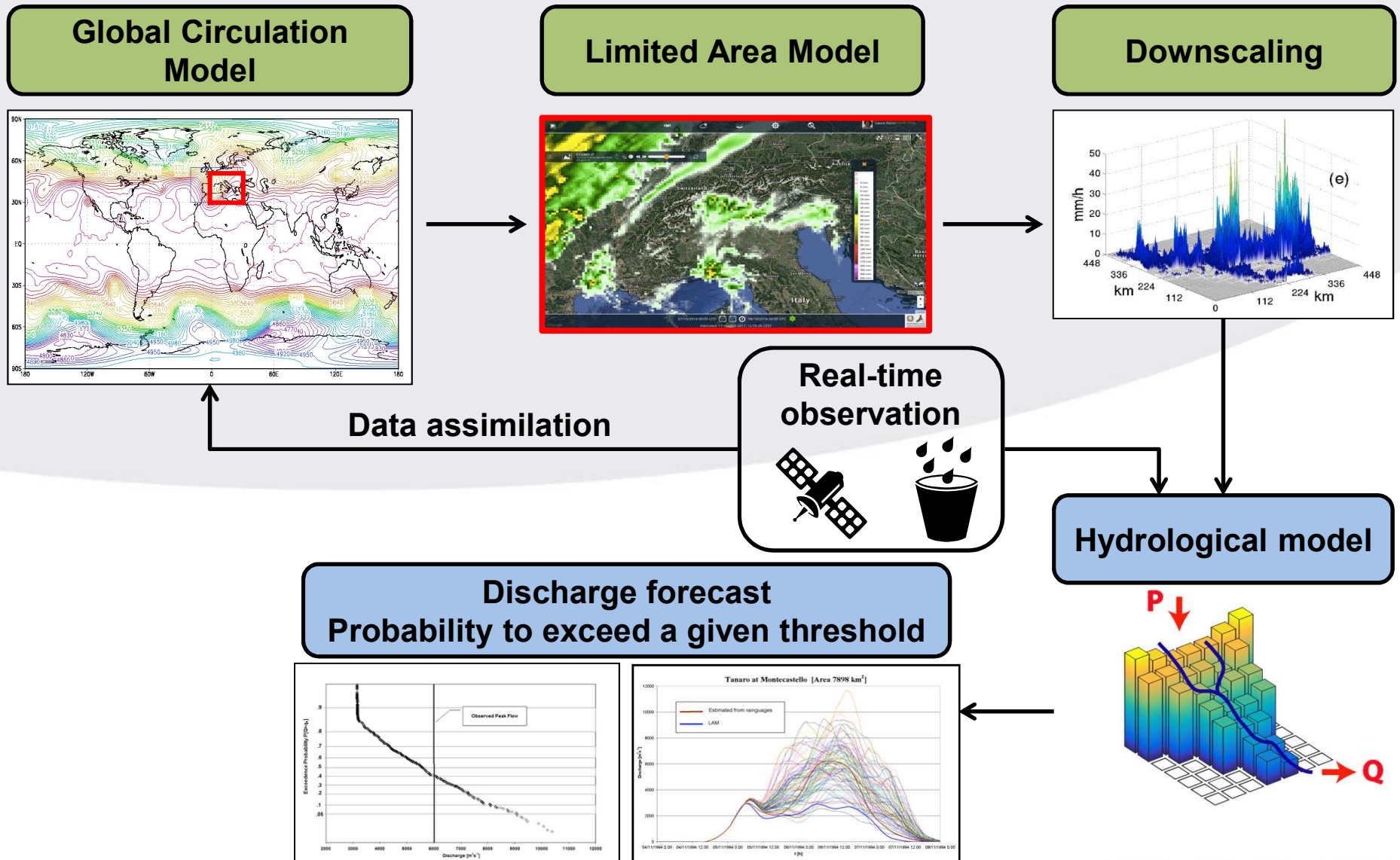
# Genoa urban area: Flash flood context



Population 600.000

Population density (2400/Km<sup>2</sup>)

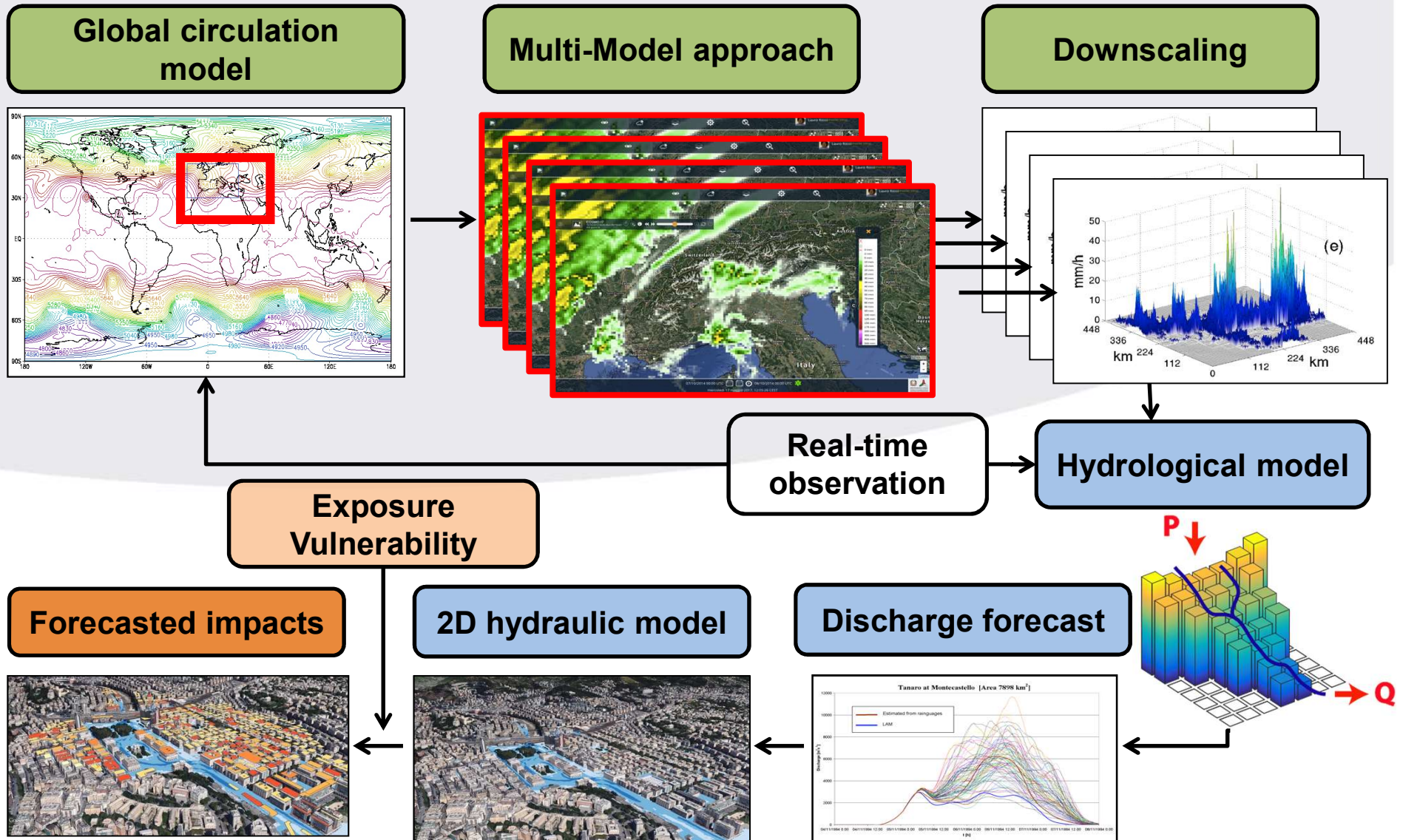
# Flash flood forecast chain



Observe to predict, predict to prevent

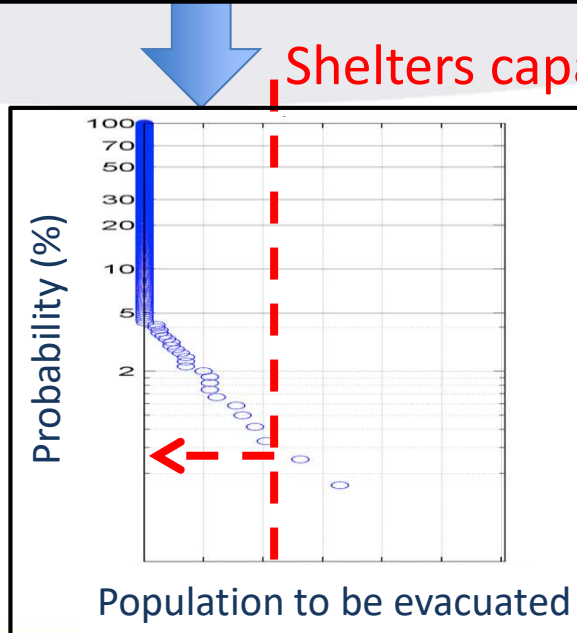
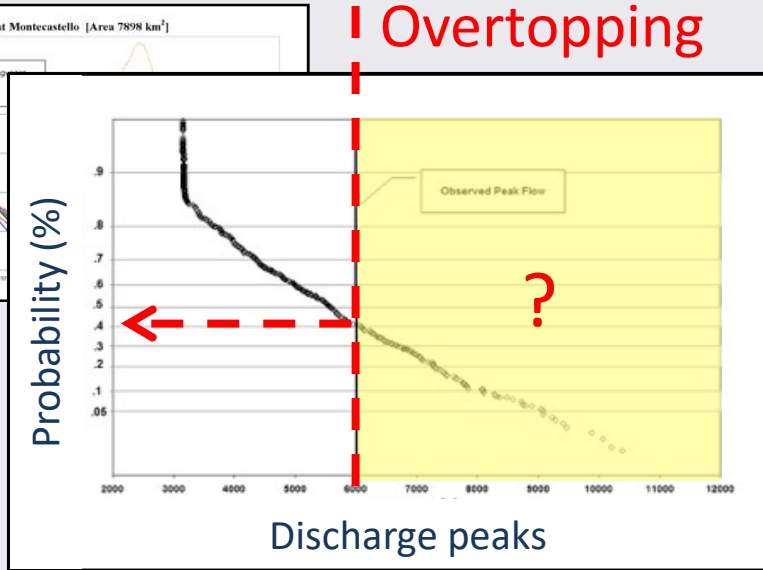
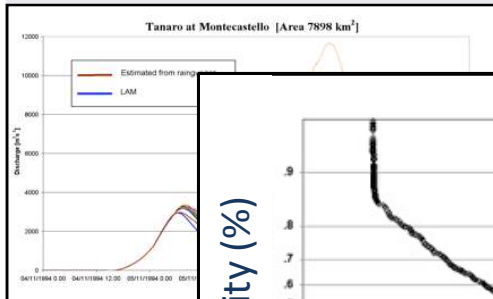


# Impact-based flood forecasting chain



Observe to predict, predict to prevent

# From hazard to impact

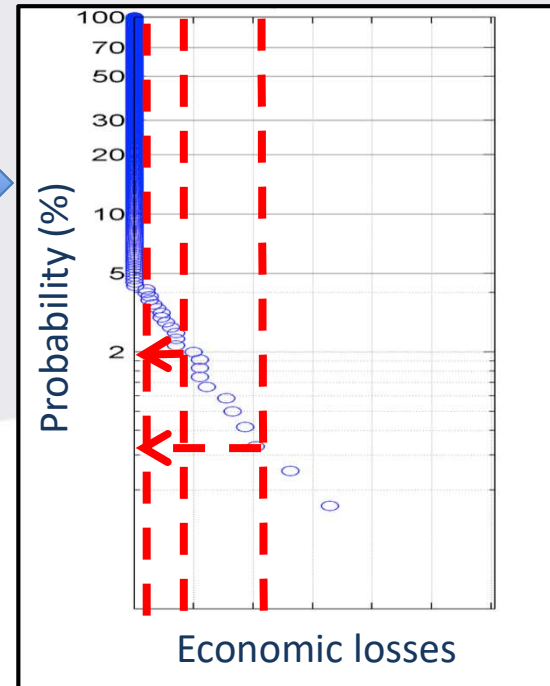


Shelters capacity

Alert costs

Emergency funds

Loss of % City GDP



# Implementation in Genoa urban area

Genoa, 9 October 2014 | Flood hazard and economic losses



Google earth

Image Landsat

Image © 2016 DigitalGlobe

© 2016 Cesium Software

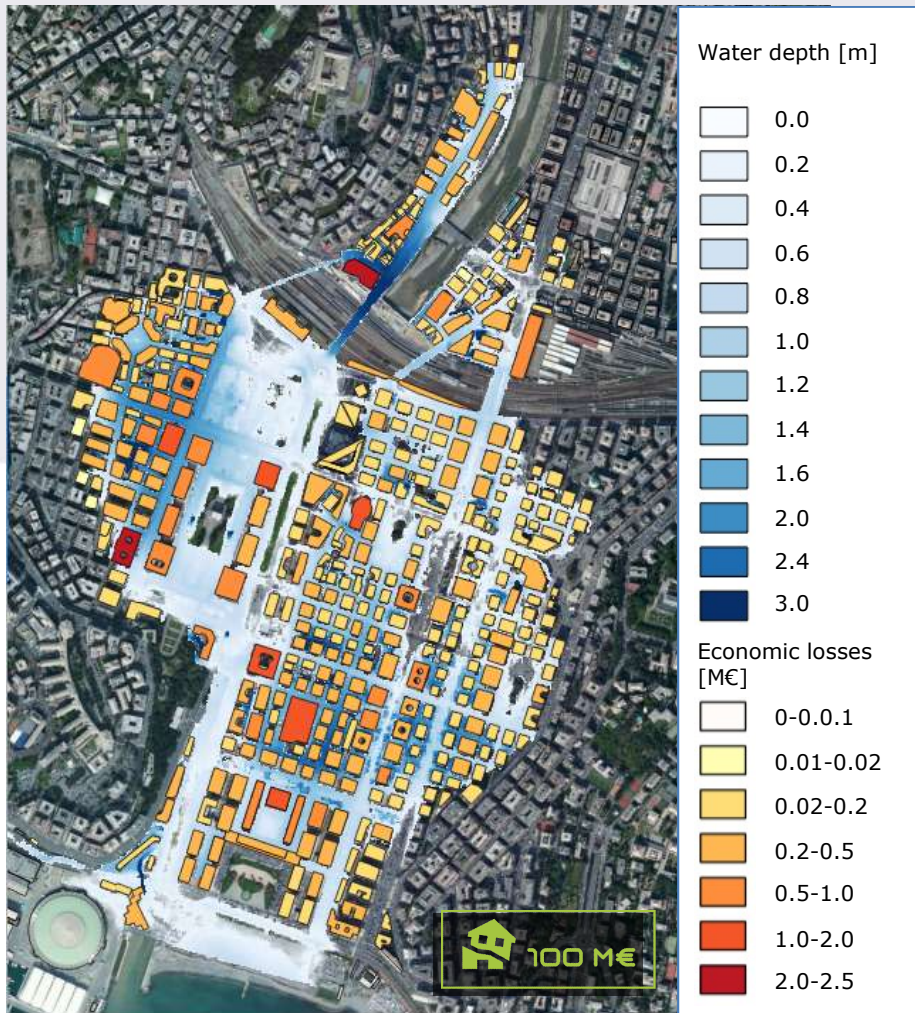
# Genoa, 9 October 2014 event



Direct economic losses



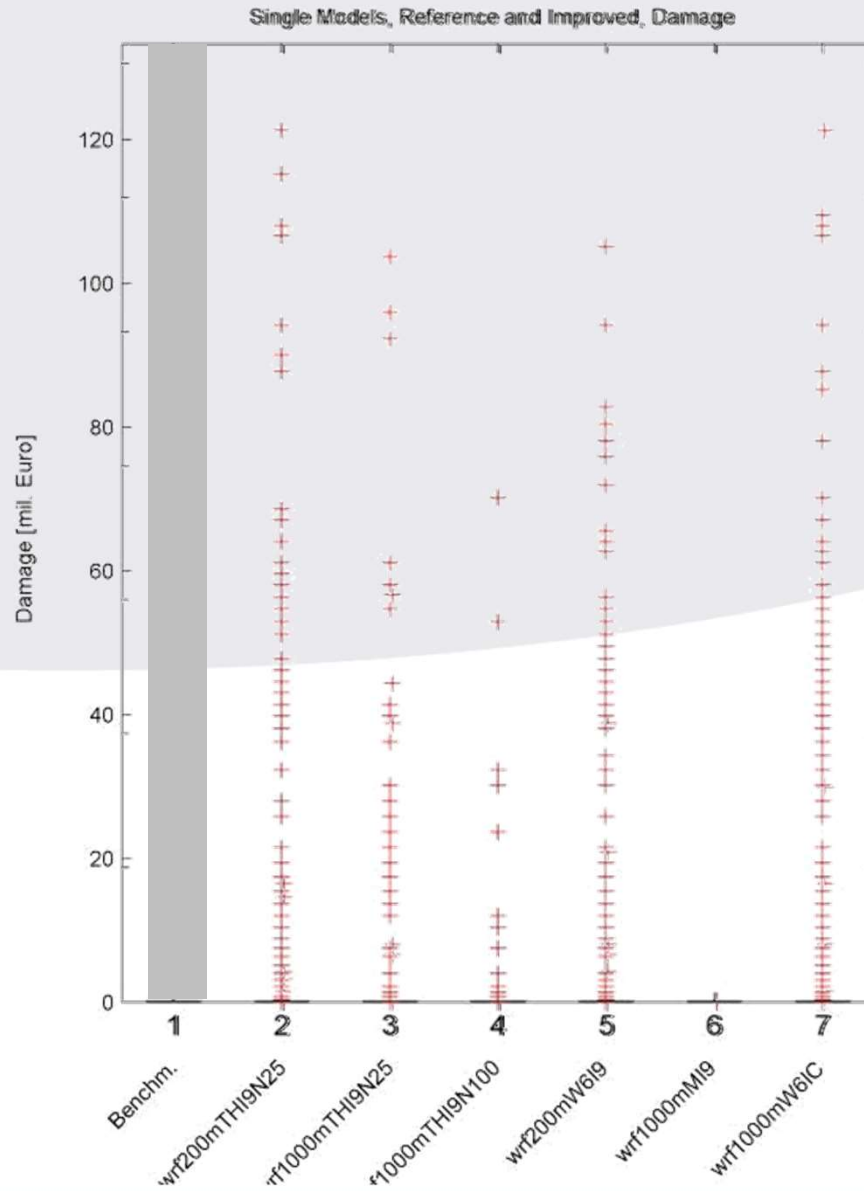
People affected in different hazard zones



## Genoa, recent flash flood past events

Past event	Discharge peak [m <sup>3</sup> s <sup>-1</sup> ]	Return period [years]	Damage, current situation [M€]
<b>1953</b>	750 m <sup>3</sup> s <sup>-1</sup>	50 years	50 M€
<b>1970</b>	1100 m <sup>3</sup> s <sup>-1</sup>	100-200 years	190 M€
<b>1992</b>	700 m <sup>3</sup> s <sup>-1</sup>	30-50 years	-
<b>2011</b>	850 m <sup>3</sup> s <sup>-1</sup>	50-100 years	45 M€
<b>2014</b>	1050 m <sup>3</sup> s <sup>-1</sup>	100-200 years	100 M€

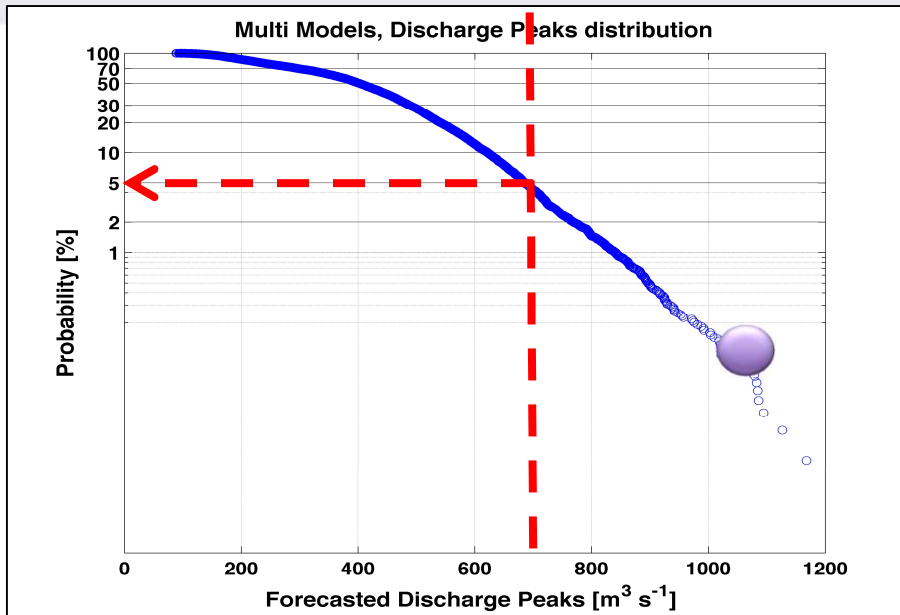
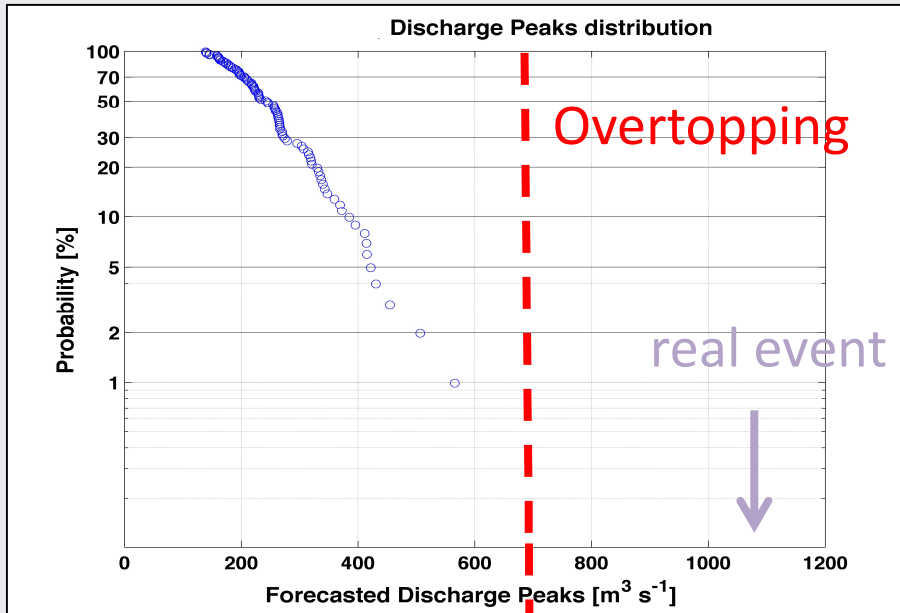
# Transformation into Damage is a low-cut filter



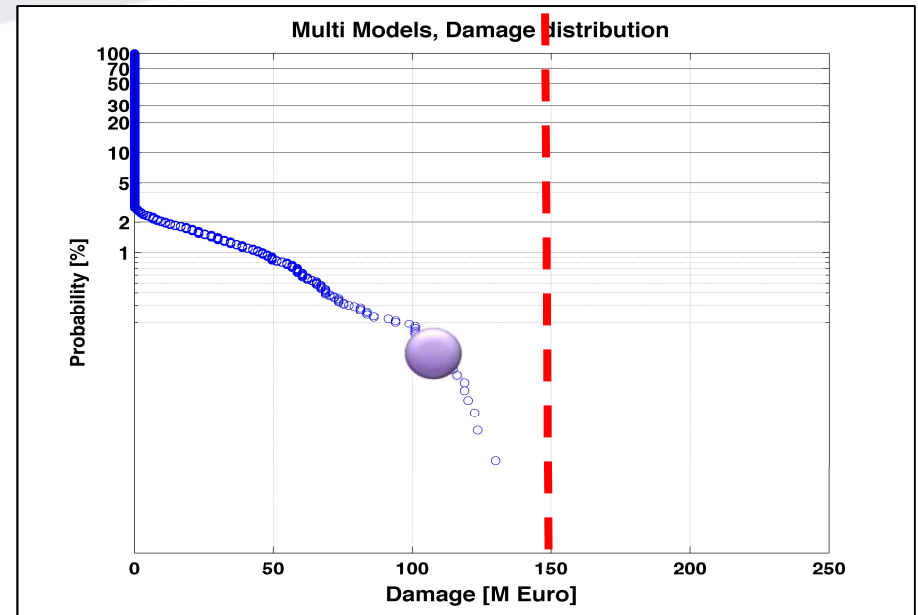
# Quantitative impact forecast

Genoa, 9 October 2014 event

present operational  
forecasting chain



0.6% City GDP



## Conclusions and Questions

Scientific/technological **tools exist** for implementations of IB-EWS at local, regional or global scale

We need to push in this direction to **advance on the technical and operational level.**

**Is science ready to support it effectively on operations?**

Accuracy and precision of assessments demand increases  
A pre-operation phase together with End Users is needed

**Is the system really ready for that?**

new procedures,  
new legislation,  
new technical preparation



**G F P**

global flood partnership

**Thank you**

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