New approach to assess CC influence in floods

increasing peak flood flows and spillway update

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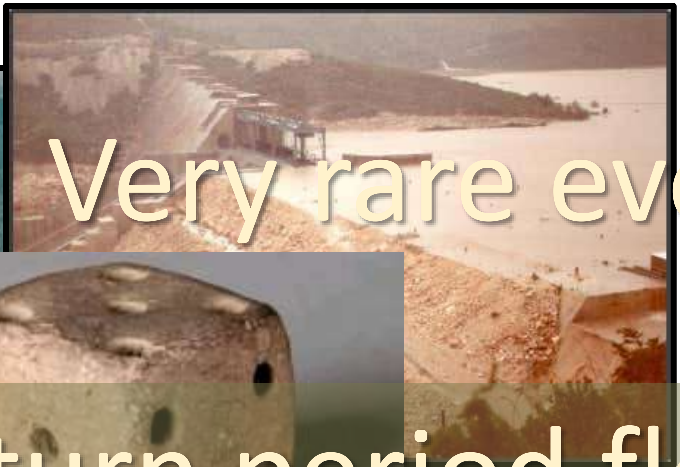
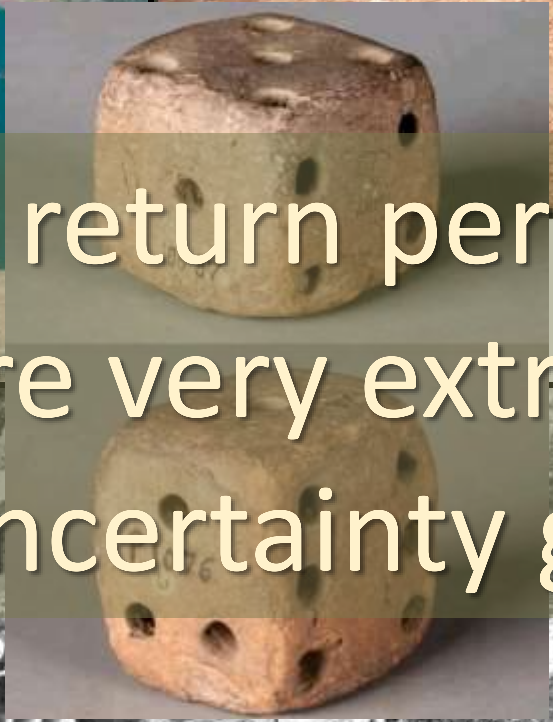
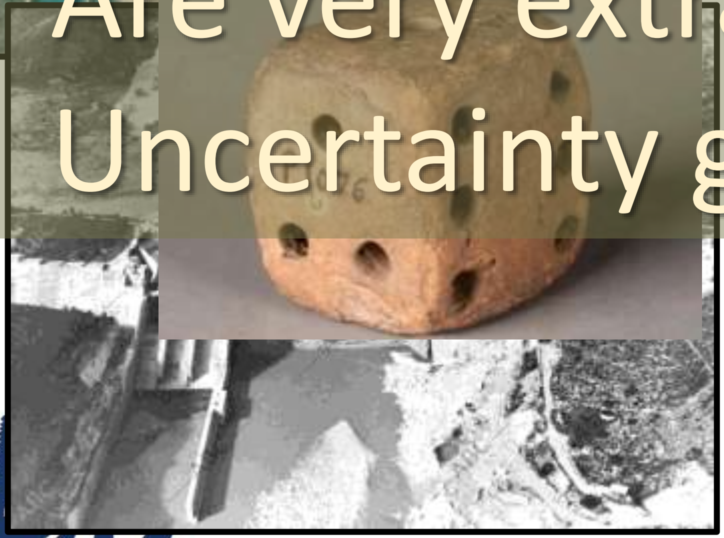
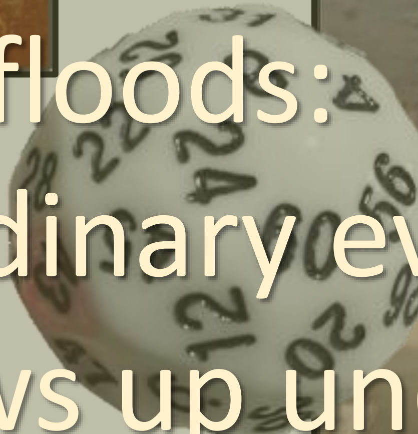
Dr. Enrique Cifres, Senior consultant
Former Vice-president of ICOLD

Very rare events

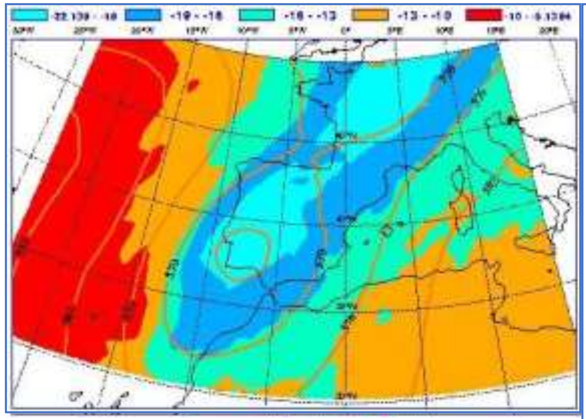

High return period floods:

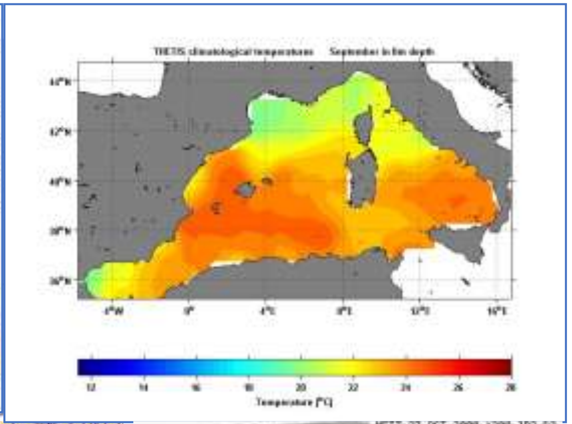
- Are very extraordinary events
- Uncertainty grows up under CC

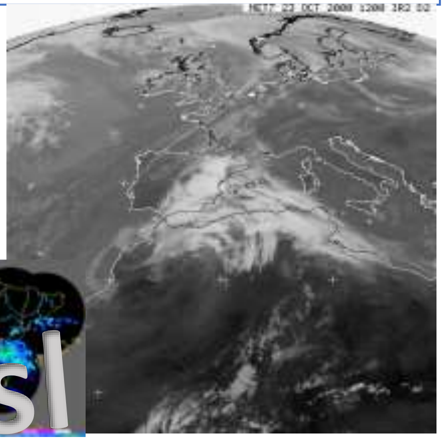
20th oct 1982
Tous dam,
Valencia (Spain)

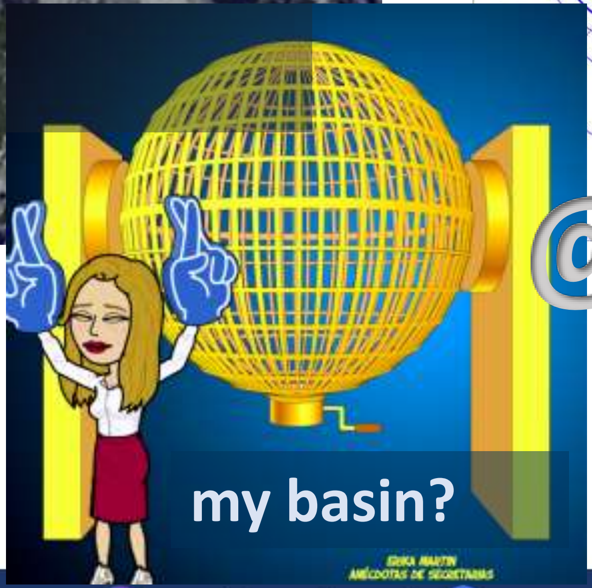
11th sep 2023
Derna dam
Libya

- Polar cold air mass moving down
- Low pressure cyclone coming from the Atlantic ocean
- Warm Mediterranean sea waters
- Blocking high pressured mass on north Europe
- …









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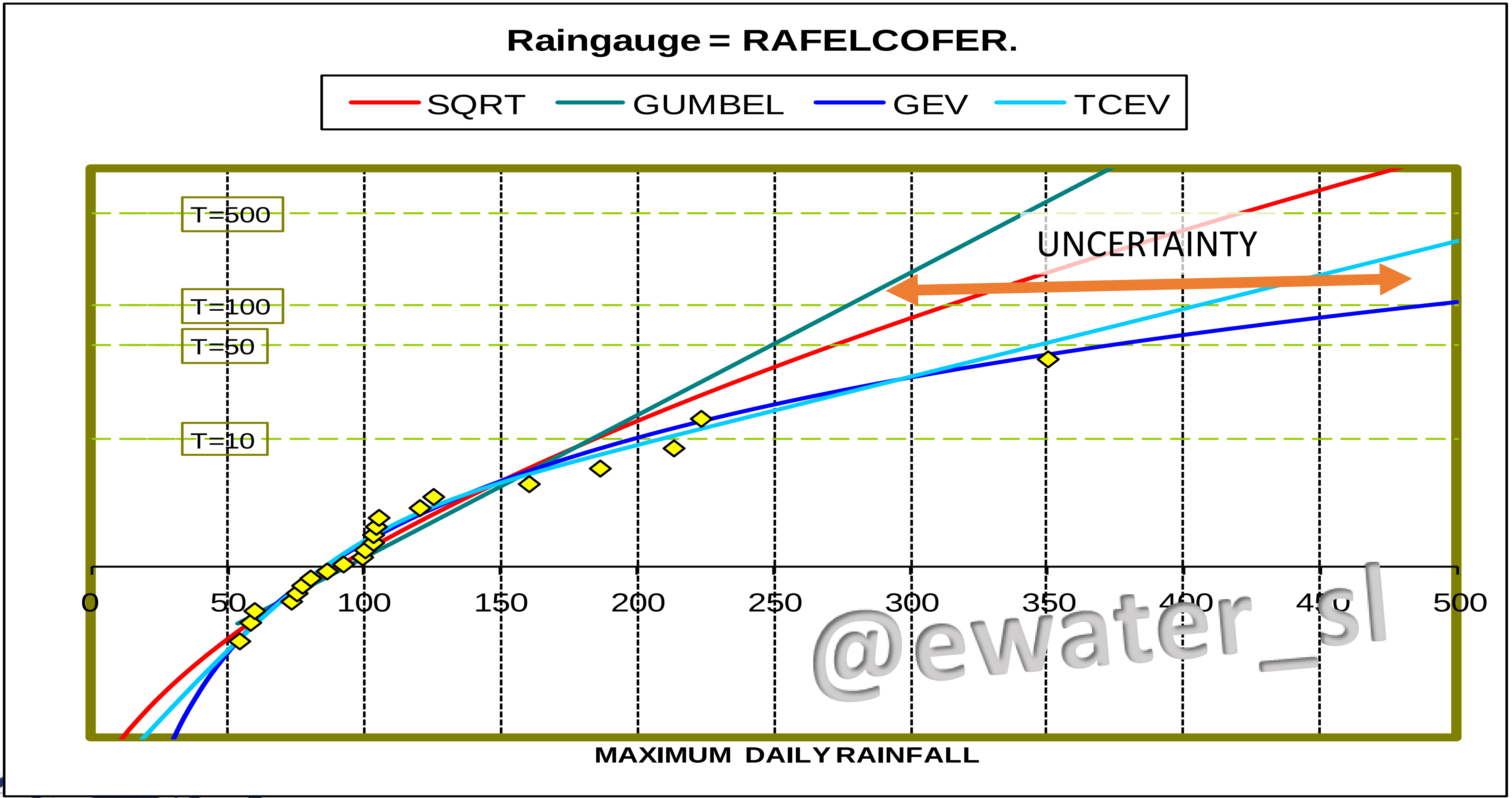
Some concerns about classical methods



The challenge

i. Hydrological safety needs to deal with floods with **very large return periods**

ii. Assessments are strongly conditioned by the **lack of reliable data** associated with extreme floods, specially under CC

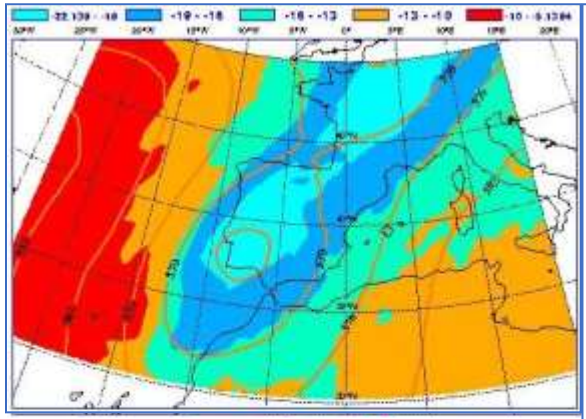
iii. Real extreme floods belong to a **particular set of events** different of ordinary ones

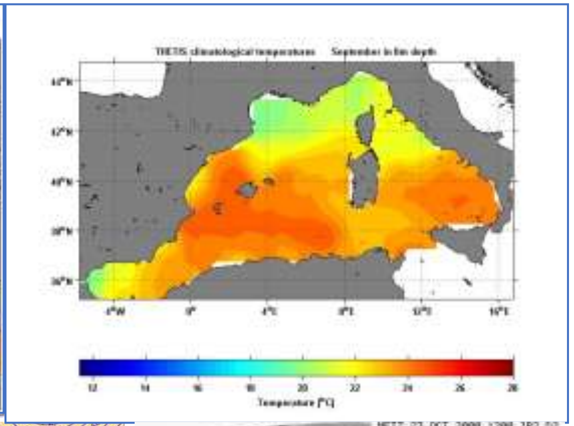
iv. Classical procedures based on extrapolation lead to **large uncertainty**

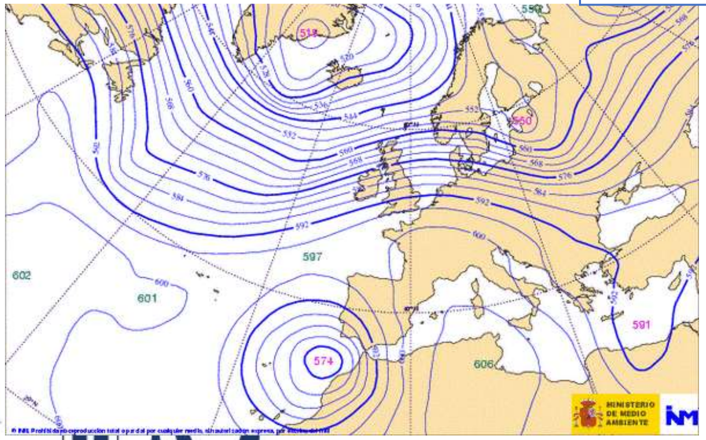
v. Most severe storms share some specific features as **near saturated** low atmospheric layers, sometimes in neighbour basins

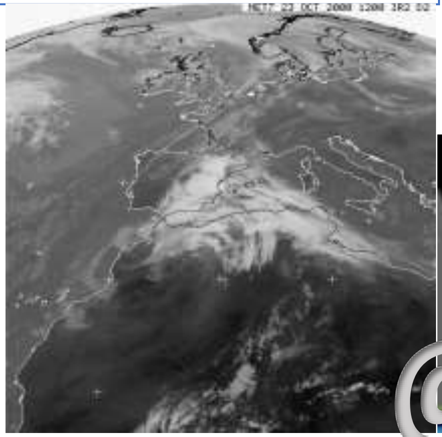
Maximum precipitable water in the atmosphere around a given area as the key concept to be considered in a NEW METHODOLOGY FOR A ROBUST ESTIMATION OF LARGE RETURN PERIOD FLOODS

Heavy storms in Med-western basins: genesis



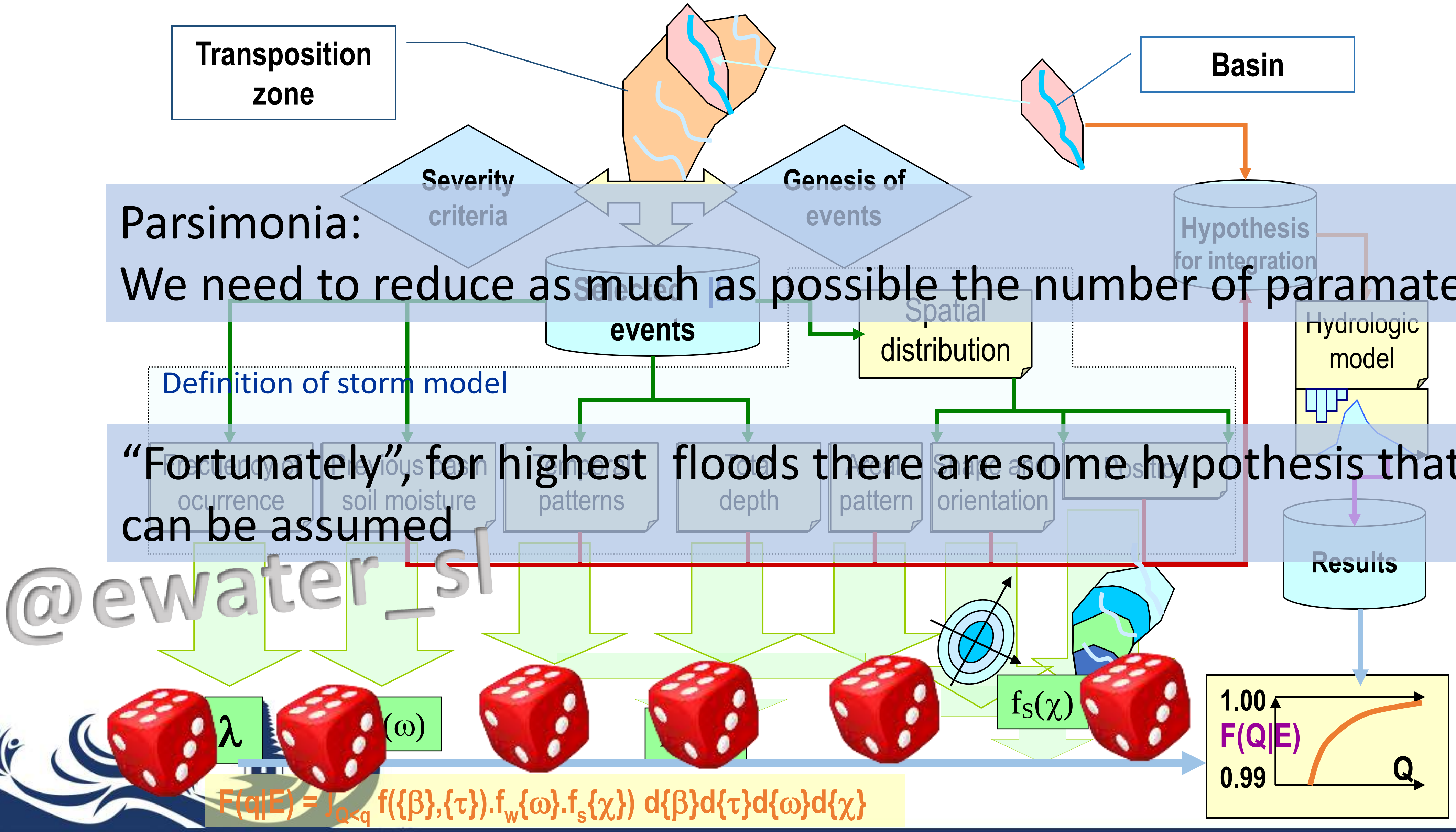






Particularities:

- –Combination.
- –Steadiness and feedback.
- –Orography.



Parsimonia:

We need to reduce as much as possible the number of paramaters

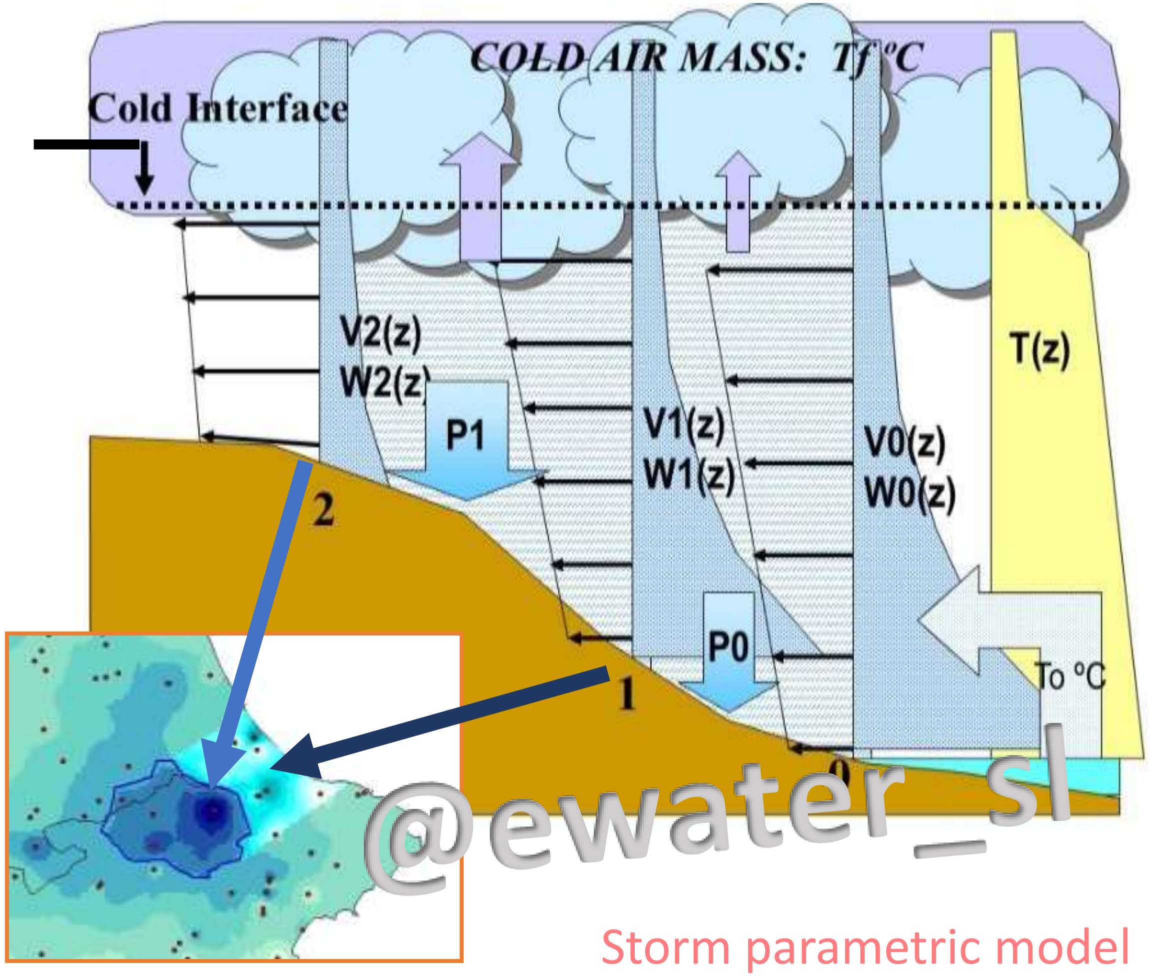
"Fortunately", for highest floods there are some hypothesis that can be assumed

Storm probabilistic characterization

Simplified model: Water content balance

Main parameters

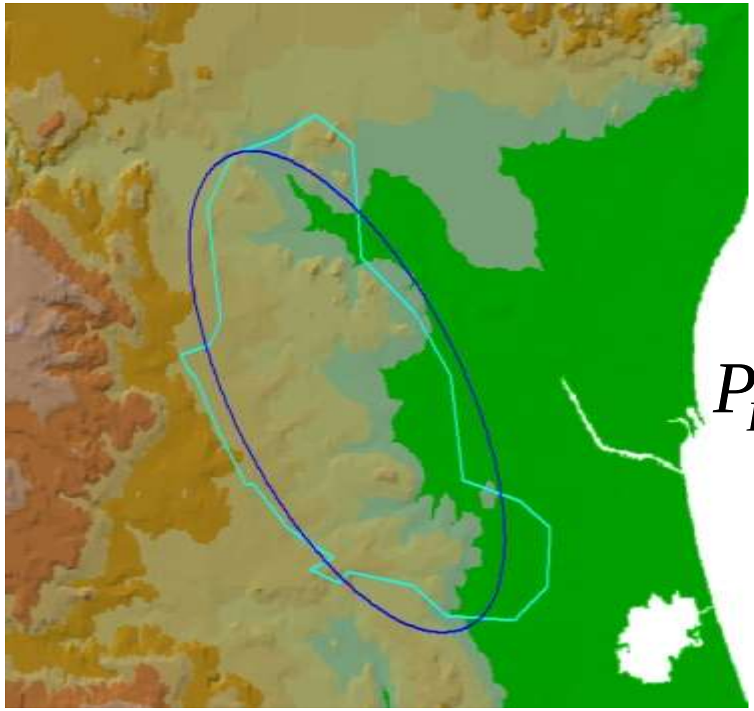
- Cold interface elevation (m)..
- Pressure at sea level (hPa).
- Dew point at coast line(ºC).
- Temperature at 500 hPa (ºC).
- Wind speed at high atmosphere level (m/s).
- Duration of the event (h)..
- Convection coeficient (dimensionless).
- Precipitation in previous zona (mm)..
- Precipitación (average) in the storm zone (mm)..

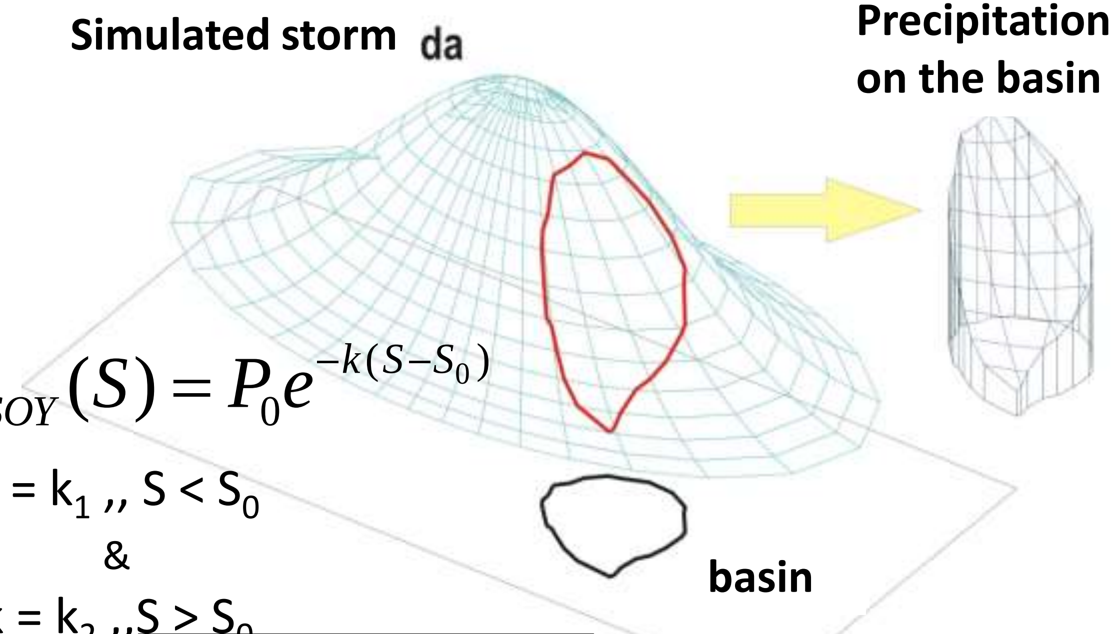


Storm parametric model

WATER FOR SHARED PROSPERITY

Simplified model: Spatial pattern



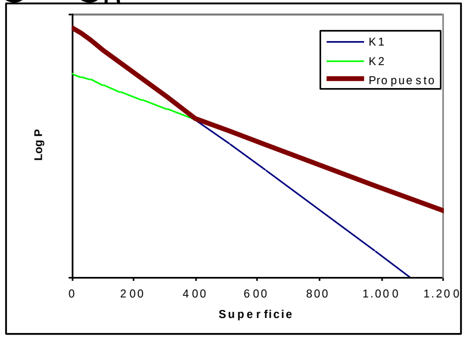


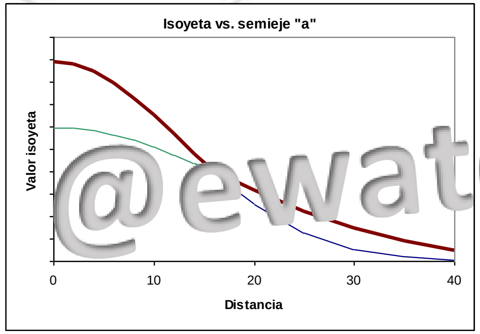
$$P_{ISOY}(S) = P_0 e^{-k(S-S_0)}$$

$k = k_1$,, $S < S_0$

&

$k = k_2$,,$S > S_0$

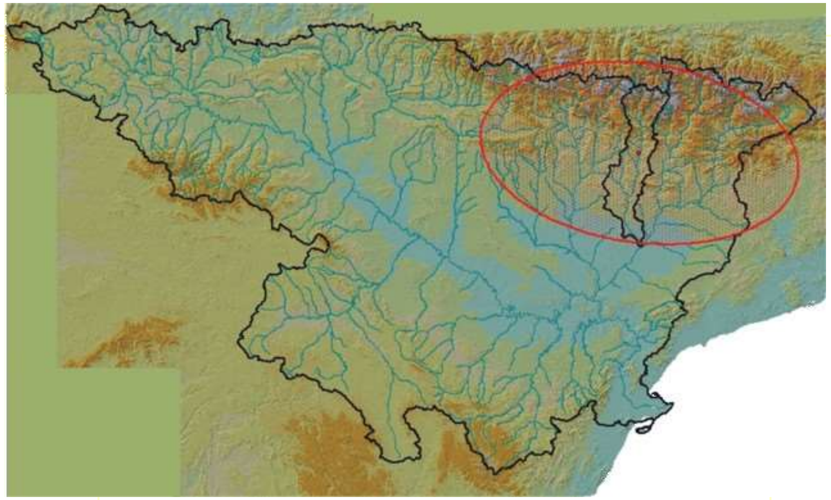


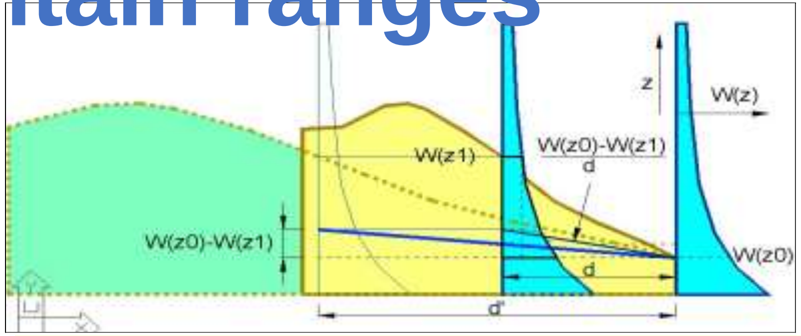


Influence of mountain ranges

Orographic ellipse concept

Mountain Ranges permit to predict shape of storms

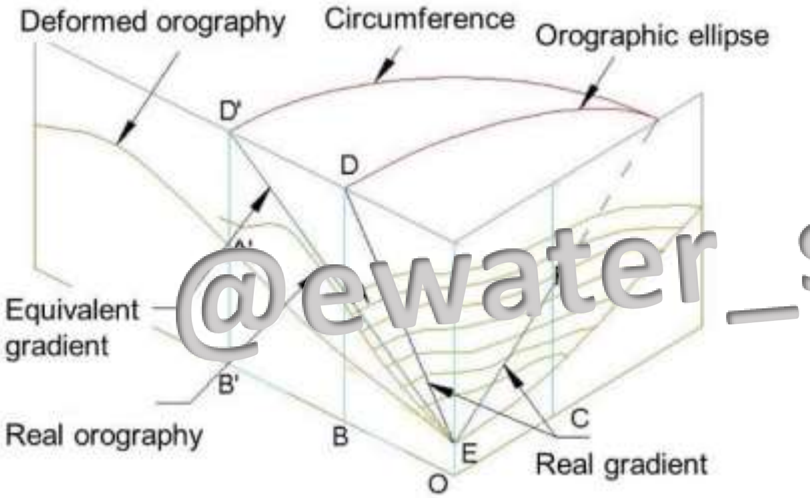




This virtual space is defined by :

φ, of **orographic orientation**

and b/a, or ν, that will be named by **orographic ratio**.

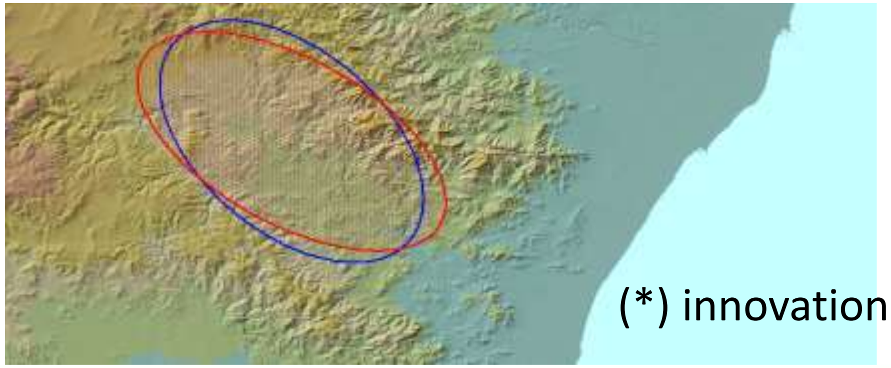


Orographic ellipses(*)

Pluviometric ellipse
(coming from recorded storm data)

Orographic ellipse
(coming from orographic maps)

We can predict storm shape



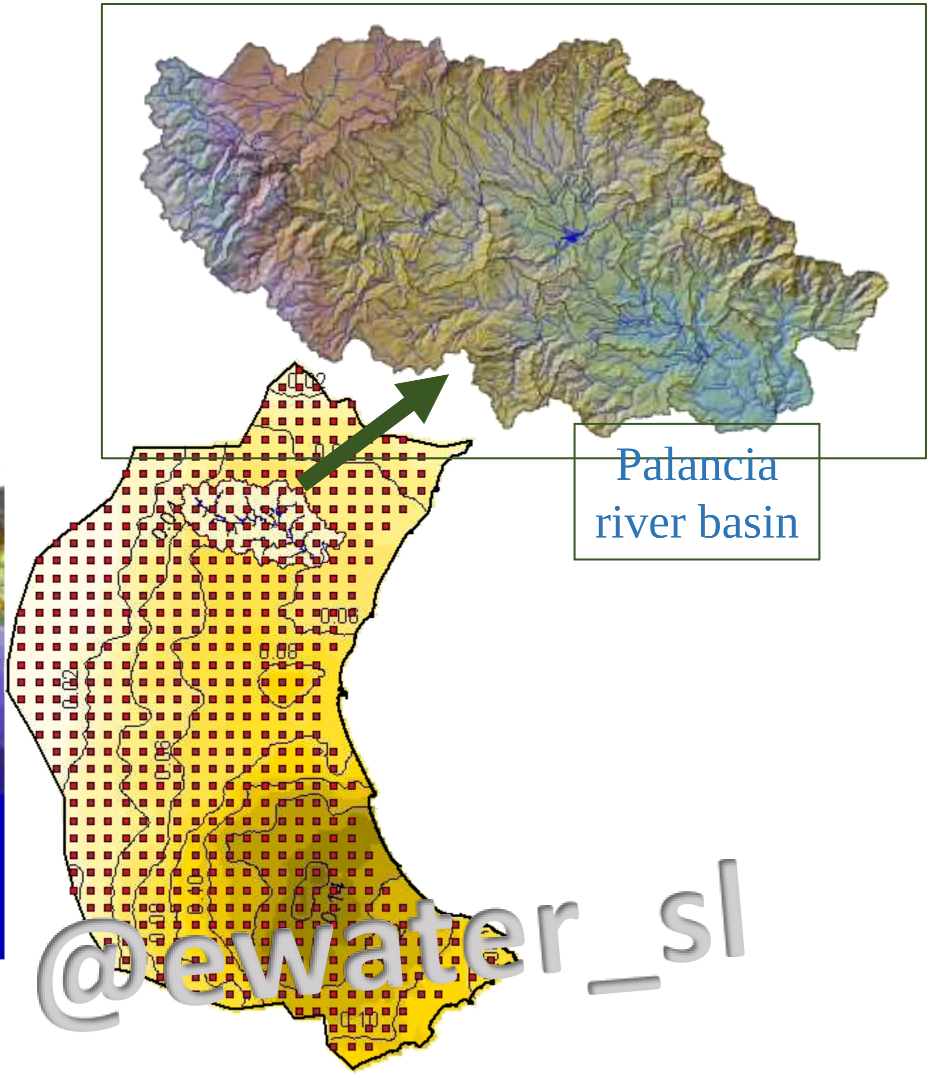
(*) innovation br E.Cifres 2004

Case study: Gulf of Valencia

Trasposition zone:

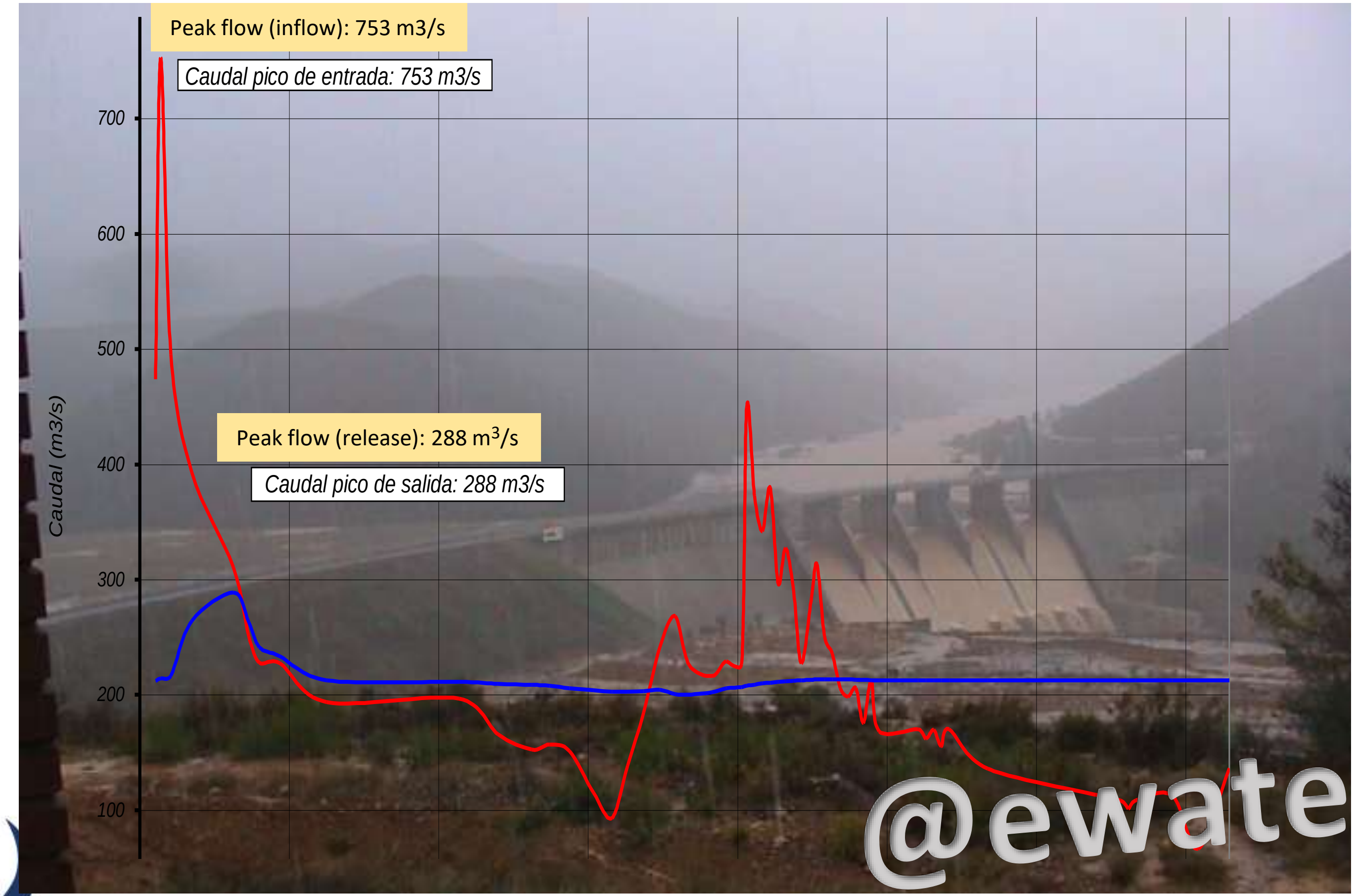
conditioned by:

- Enough number of events (severity criterion)
- Reliable event transposition
- Geomorphological qualitative criteria



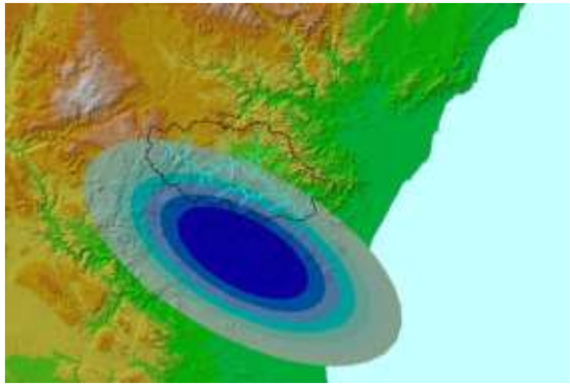
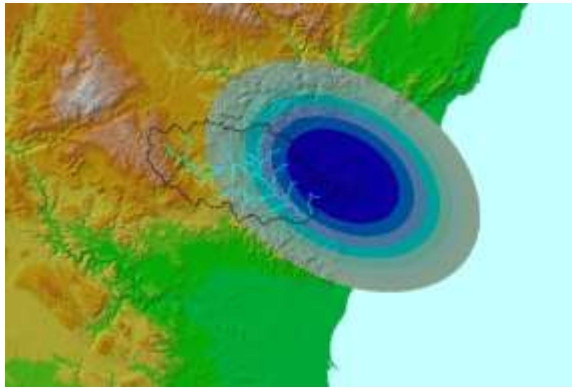
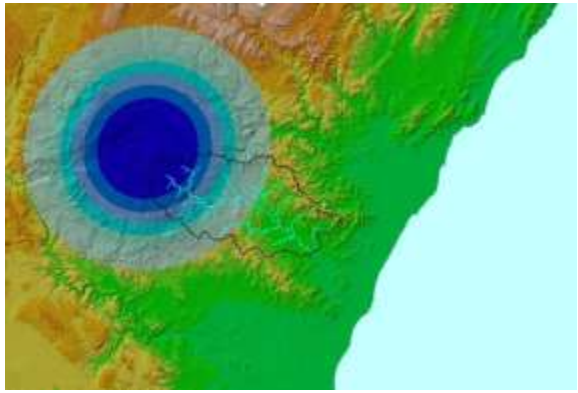
Case study: Gulf of Valencia-Algar dam

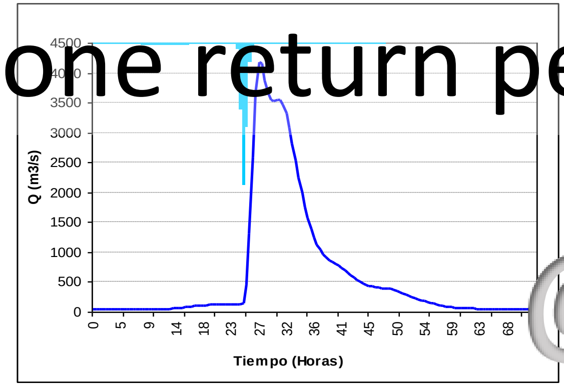
Real event Oct, 2000 (Algar dam, Palancia River)

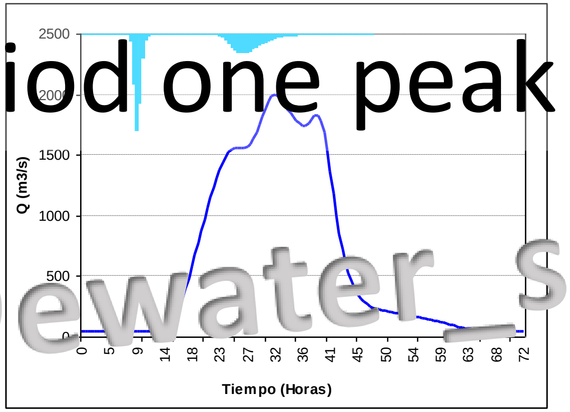


Case study: Gulf of Valencia-Algar dam

Many different storms with the same probability can be simulated

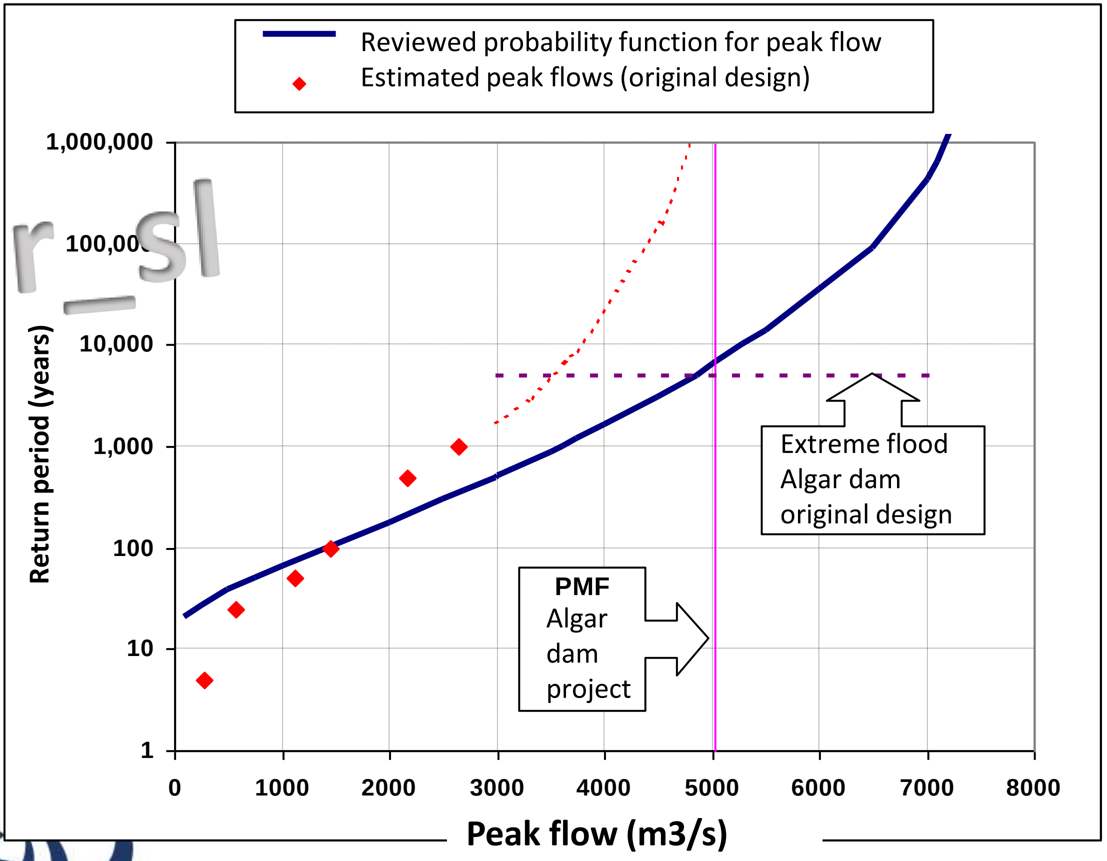








Forget the idea of one return period one peak flow

Case of study: Algar dam flood design-review
Results



- PMF was selected as flood design criterion
- Also conventional extrapolation were assessed for diferent return period floods.

Algar dam project, Cifres E. (1993)

Fortunately, reviewing flood frequencies with this new tool (Stochastic transposition) PMF could be evaluated as a 6,500 years return period.
Nowadays 10.000 year return period for new **Spanish regulation** is only 5% higher

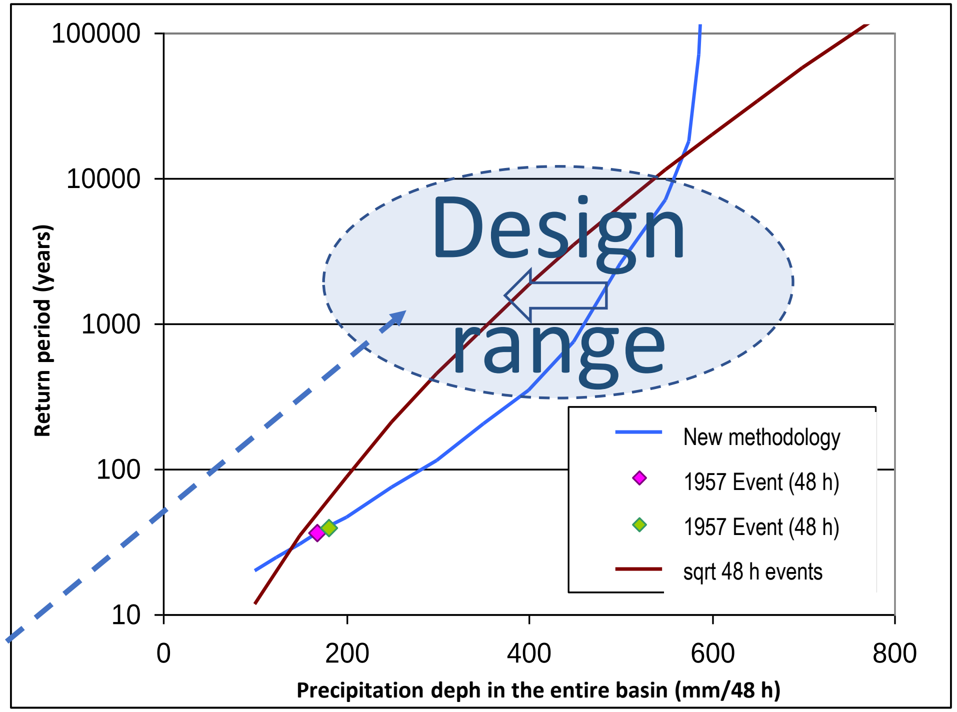
Some conclusions

Feasibility of Stochastic and orographic transposition for **practical purposes**.

Physically based models can **reduce stochastic component**, giving to the overall model **more parsimony**.

We can take practical advantages from detailed studies about winds, temperatures,. and orography.

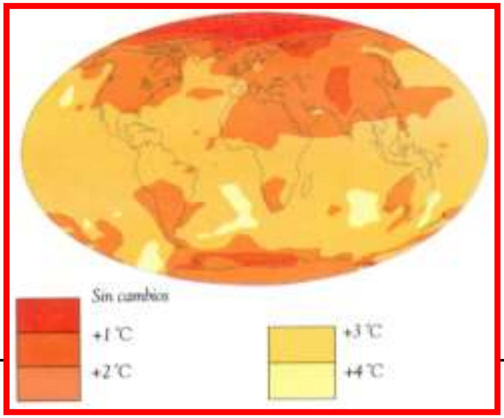
Sometimes:
Under-estimation in design range. Be aware!

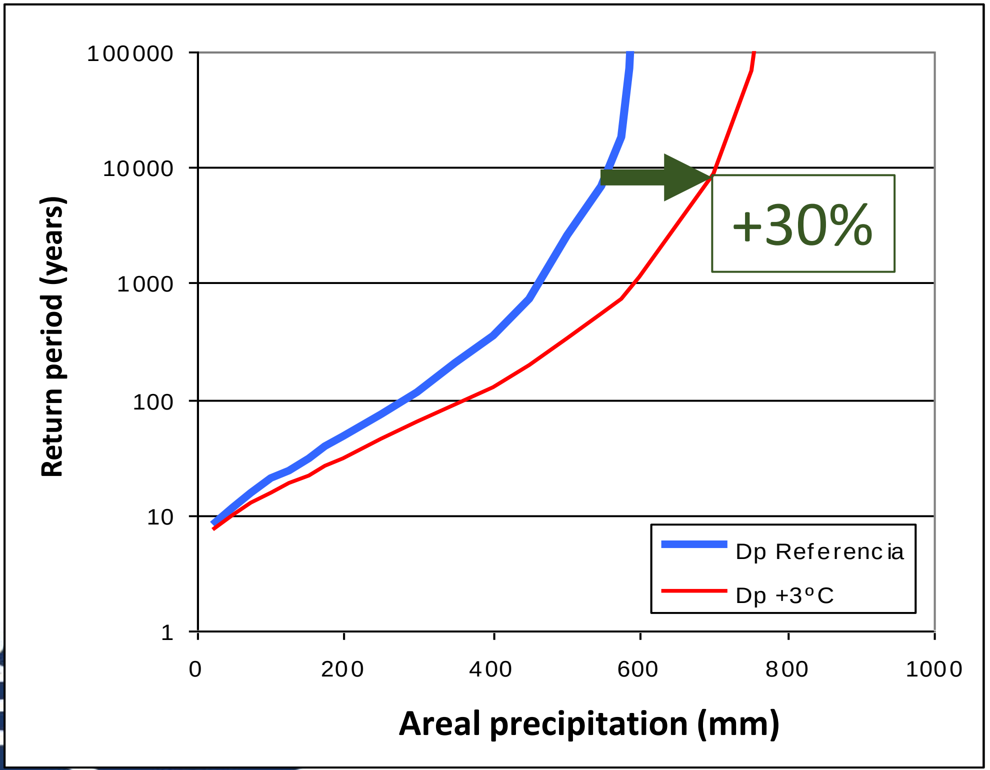


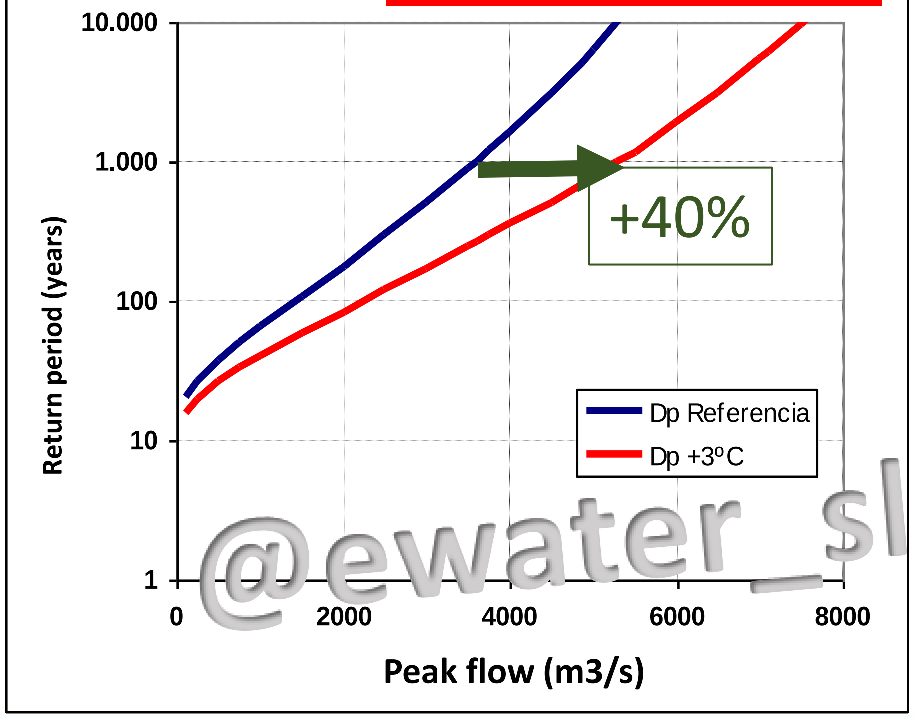
Climate Change impact

Parametric analysis.

Just modifying **dew point** it's possible to re-assess probability function and identify the impact of one parameter as sea temperature that governs storm depths.







Challenges, our commintment

- Modernizing methodologies. Repeating classical studies with CC data changes is not enough.
- Assuming that the revision of hydrology entails the admission, in many cases, of greater risks than estimated
- Establishing margins of uncertainty in the design of hydraulic structures is recommended
- Updating studies with consideration of Climate Change relevant parameters.
- Foreseeing investments to face flood risk evolution due to CC by means of infrastructure updating.
- Complementing with non-structural measures, such as RTWS and Emergency Action Plans

Thank you for your attention

Terima kasih banyak atas perhatiannya

Muchas gracias por su atención

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