Applications of PUB in practice in southern Africa

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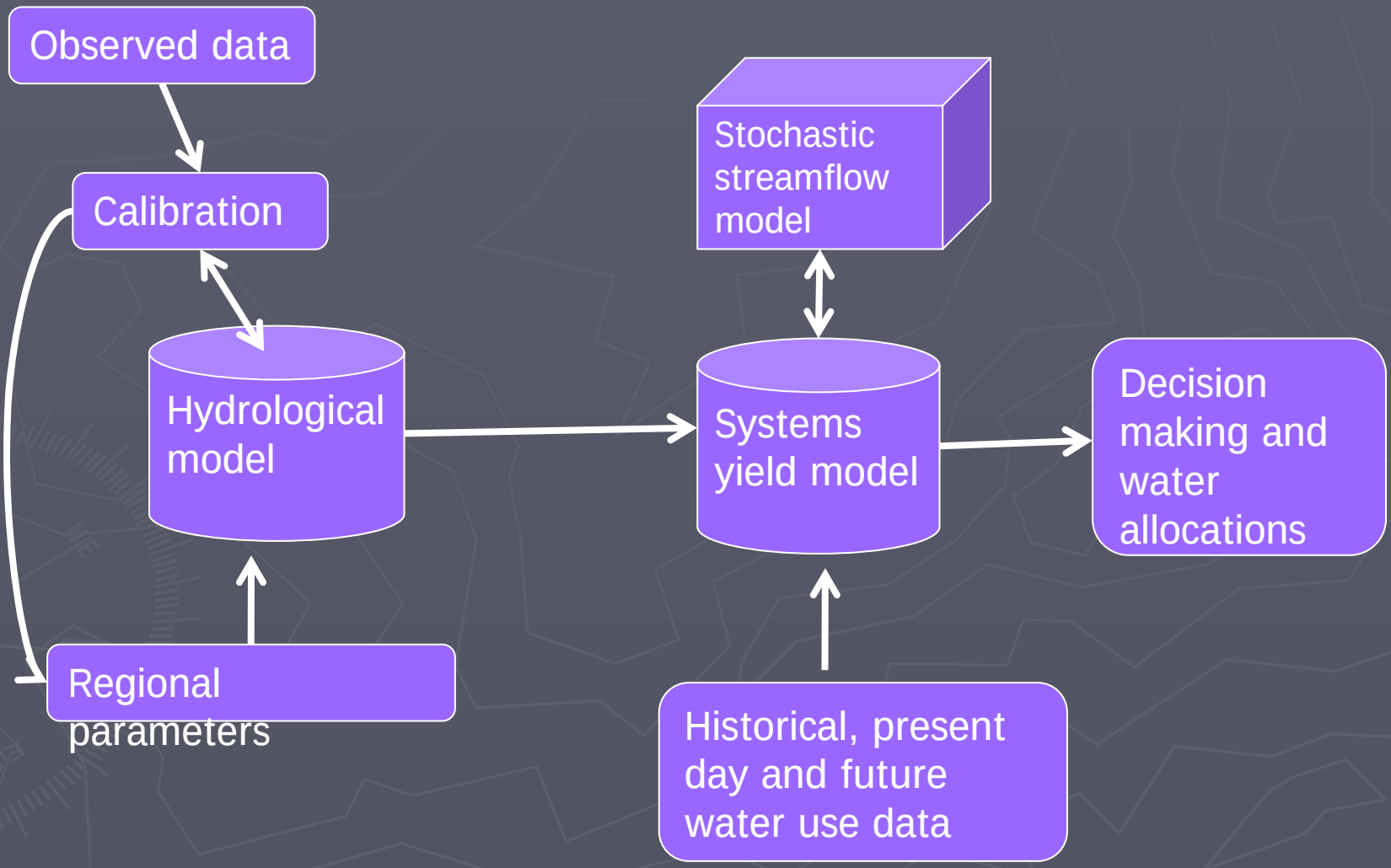
Background

- Models have been used for water resources assessments for many years:
  - Pitman monthly rainfall-runoff model for estimating natural hydrology and some changes (e.g. land use change effects).
  - Water Resources Yield Model (WRYM) to simulate development impacts (reservoirs, abstractions & return flows) and operating rules under different scenarios.

Traditional approach



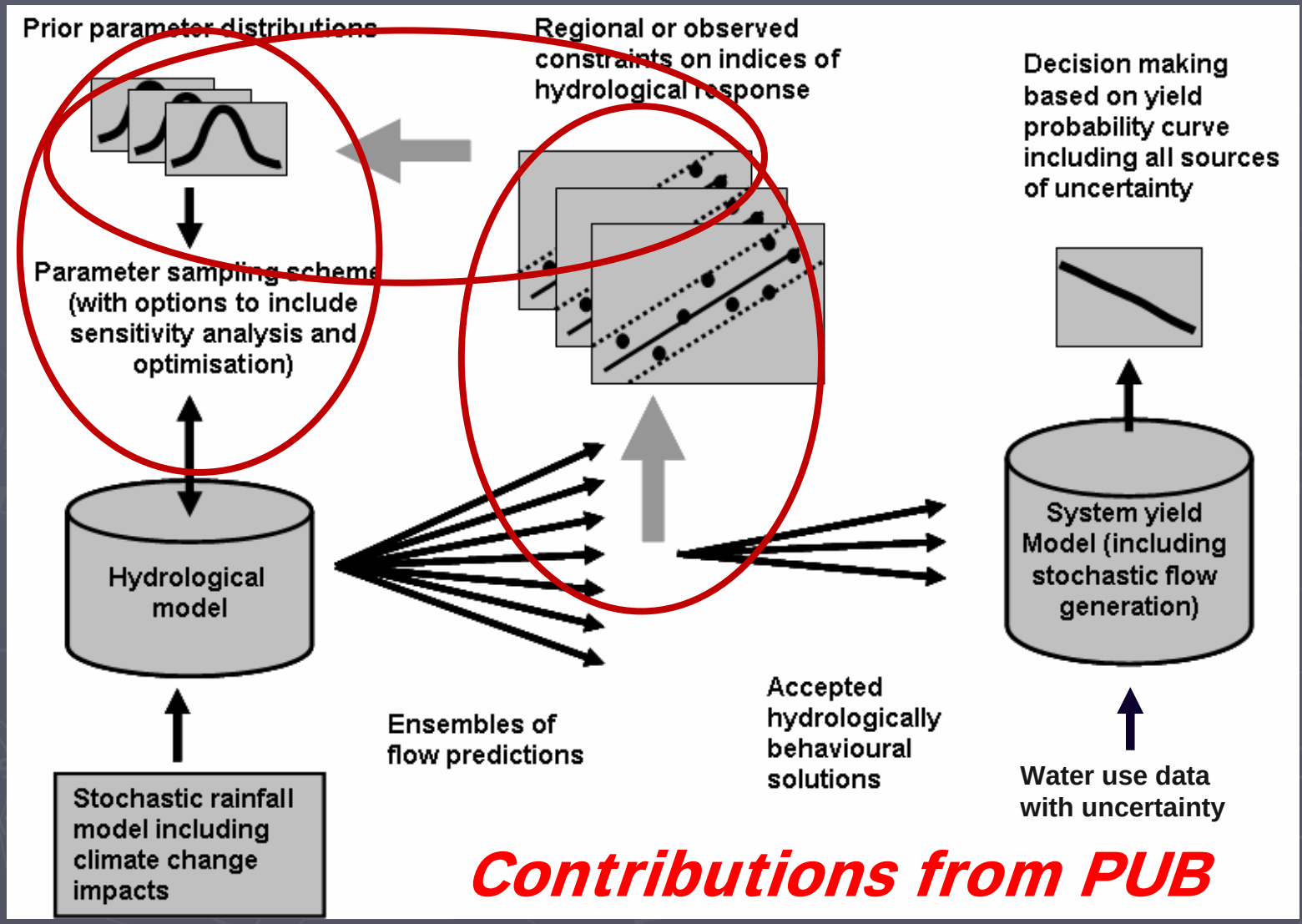
Problems

- Stream flow gauging data rarely represent natural conditions:
  - Naturalisation process confused by inadequate historical data on upstream development & patterns of water use.
  - Impacts on calibration results
- Poor rainfall data in some areas (mainly mountainous regions).
  - Parameter sets could be biased to input errors.
- Use of ‘catchment similarity’ approach has been largely subjective:
  - No real basis for establishing similarity & no independent tests.
  - Regional parameter sets uncertain, but not quantified.

Is there an alternative approach?

- That includes:
  - Recent international developments in the concepts of uncertainty in hydrological modelling.
  - Principles and developments of PUB.
- And is:
  - Practical to apply under SA conditions.
  - Does not require a complete change to existing approaches to water resources assessment (there would be a lot of resistance to a major change).
  - Can be applied with existing models.

An uncertainty framework



How can PUB support the practical application of the framework

- Parameter estimation procedures:
  - Understanding processes as the catchment scale.
  - Understanding distributions of hydrological processes across complex landscapes.
  - Scaling rules across different size catchments.
  - Estimation of residence times and flow paths using isotope data, etc.
  - Characterisation of storage & fluxes.
  - Transfer of parameters from donor catchments with parameter likelihoods.
  - Similarity weighting.
  - Non-stationary parameter values linked to climate.

How can PUB support the practical application of the framework

- Constraints on model ensemble outputs:
  - Hydrological indices used to condition model ensemble outputs (SCS curve number & others).
  - Using hydrological state variables as well as output stream flow (information obtained from remote sensing or other sources).
  - Regional signatures of catchment response (residence times, storage-discharge relationships, GW contributions, etc.).
  - Use data rich information to help in data poor situations.
  - Use focused, short-term field observations.

How can PUB support the practical application of the framework

- Feedback loop from constraint analysis to parameter estimation:
  - Using model outputs to assess process understanding.
  - Identifying critical processes/parameters that generate most output uncertainty (sensitivity analyses).
  - Reducing the uncertainty in model parameters.
  - Identifying parameter redundancy.

How can PUB support the practical application of the framework

- Others
  - Parameter sampling schemes across different model complexities to achieve realistic expressions of output uncertainty (given huge sampling space).
  - Identifying model structural inadequacies and needs for improved models.
  - Using satellite or NCM data to substitute for inadequate model forcing data.
  - Proving to practitioners that uncertainty assessments are possible, practical and essential.

Research -> Practice

- Some of the PUB contributions are research areas that could improve techniques that can be applied in practice.
  - e.g. develop better parameter estimation procedures.
- Others are contributions that can be applied directly in practice.
  - e.g. ensemble outputs to generate yield probabilities to inform water resource decision making risk.