SCENARIOS BASED LAND USE/COVER CHANGES IMPACT ON FLOOD REGIME IN THE OUÉMÉ BASIN, (BENIN REPUBLIC)

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OUTLINE

- Background and Problem Statement
- Data and Methodology
- Results and Discussions
- Conclusions

Background and Problem Statement

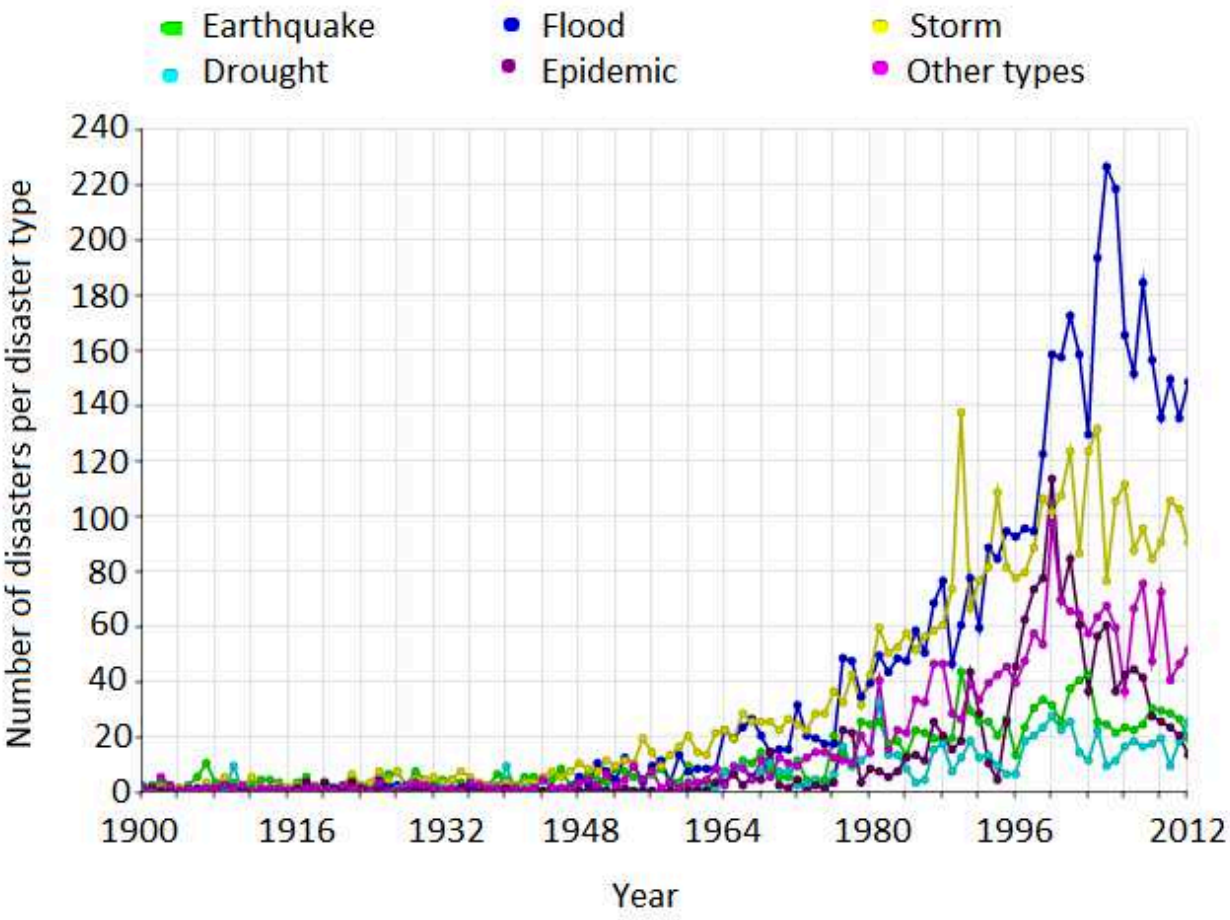


Figure 1: Trend in Natural disasters types (Earthquake, Flood, Storm, Drought, Epidemic) from 1900 to 2014 all over the world

Background and Problem Statement

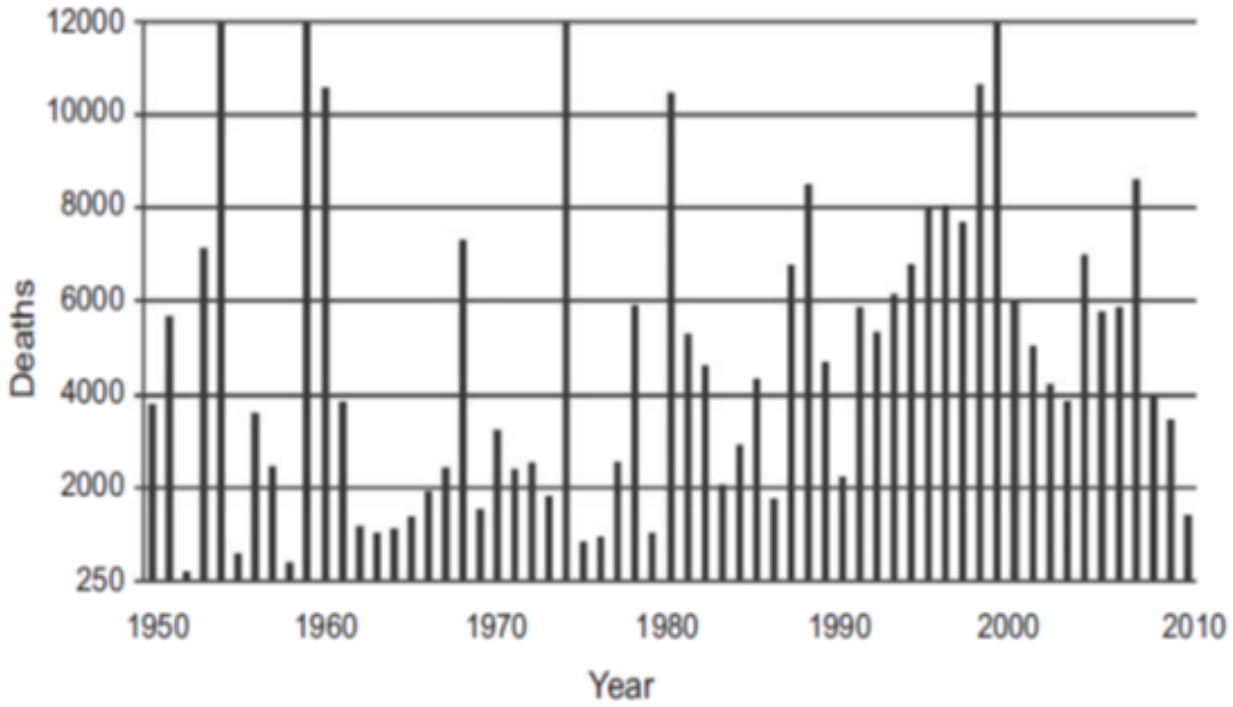


Figure 2: The number of deaths caused by flood disasters in the world (source : EM-DAT CRED)

Background and Problem Statement

- **1900 to 2006, flooding in Africa (ICSU, 2007) :**
  - killed nearly 20,000 people
  - affected nearly 40 million more
  - caused damage estimated at about US$4 billion ;
- **In West Africa, the number of floods is increasing.**

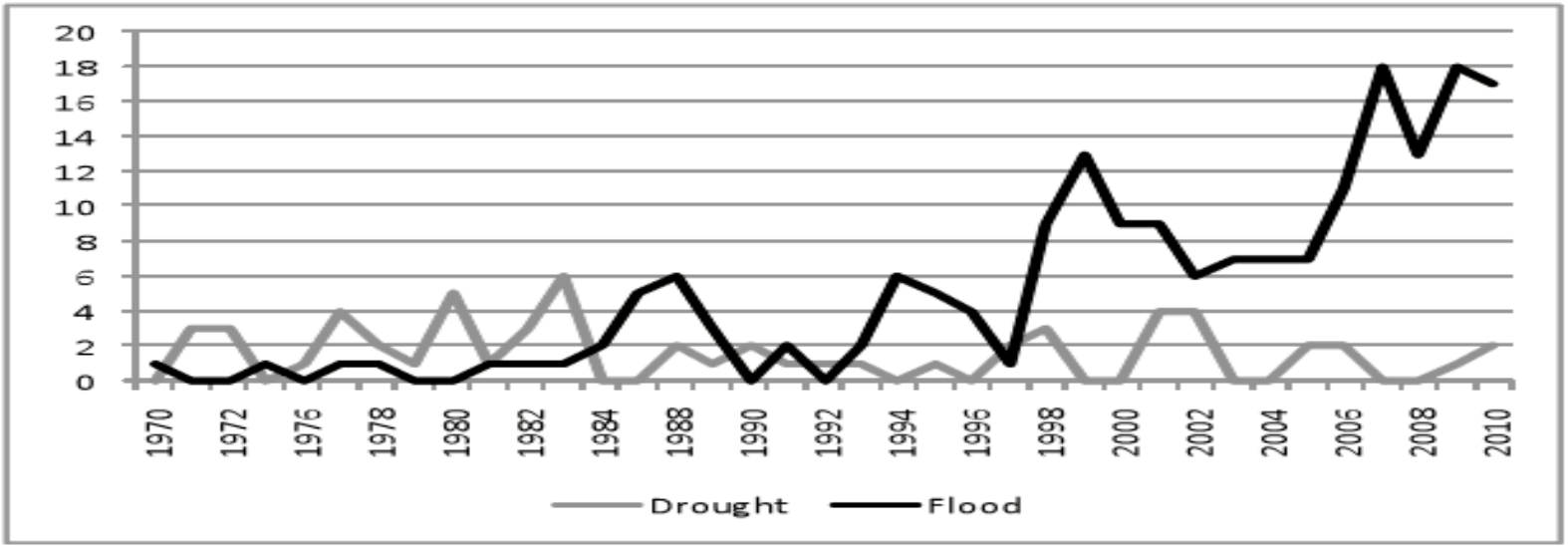
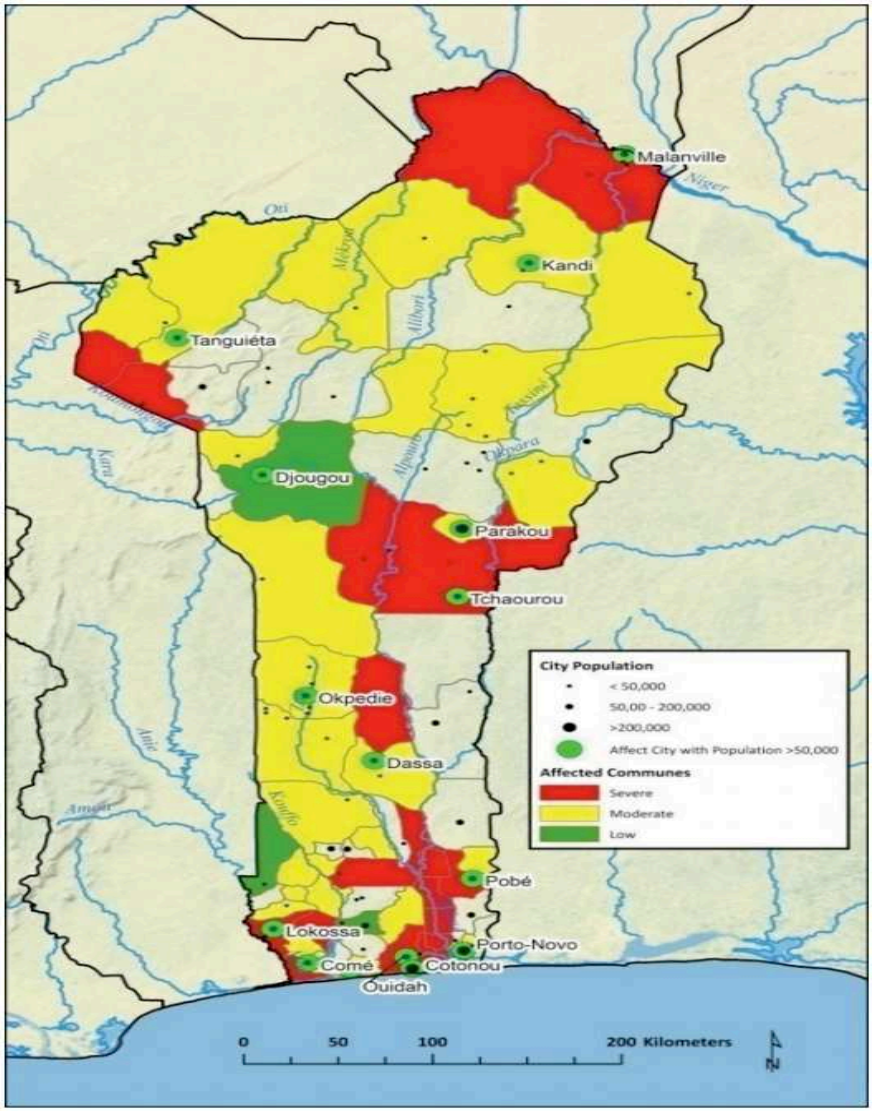


Figure 3: Flood disasters Number in West Africa

FIGURE 4: Example of flood disasters in Africa

- **Between 1980 and 2009, there have been 14 major floods affecting a total of 2.26 million people (EM-DAT, 2010) in Benin...**

Figure 5: Example of flood disasters in Benin



2010 flood in Benin

- **680,000 people affected 46 dead,**
- **55/77 municipalities affected,**
- **50,000 homes destroyed,**
- **128,000 ha of crops destroyed. (World Bank, 2011)**

Figure 6: Flood map (World Bank,2011)

Introduction. . .

Research question

- **What will be the change in magnitude (frequency) for a peak flow with a frequency (magnitude) of interest after change in LULC ?**

Objective

- To applying multi-modelling approach and statistical methods for evaluating possible changes in flood frequency and magnitude using a set of land use scenarios.

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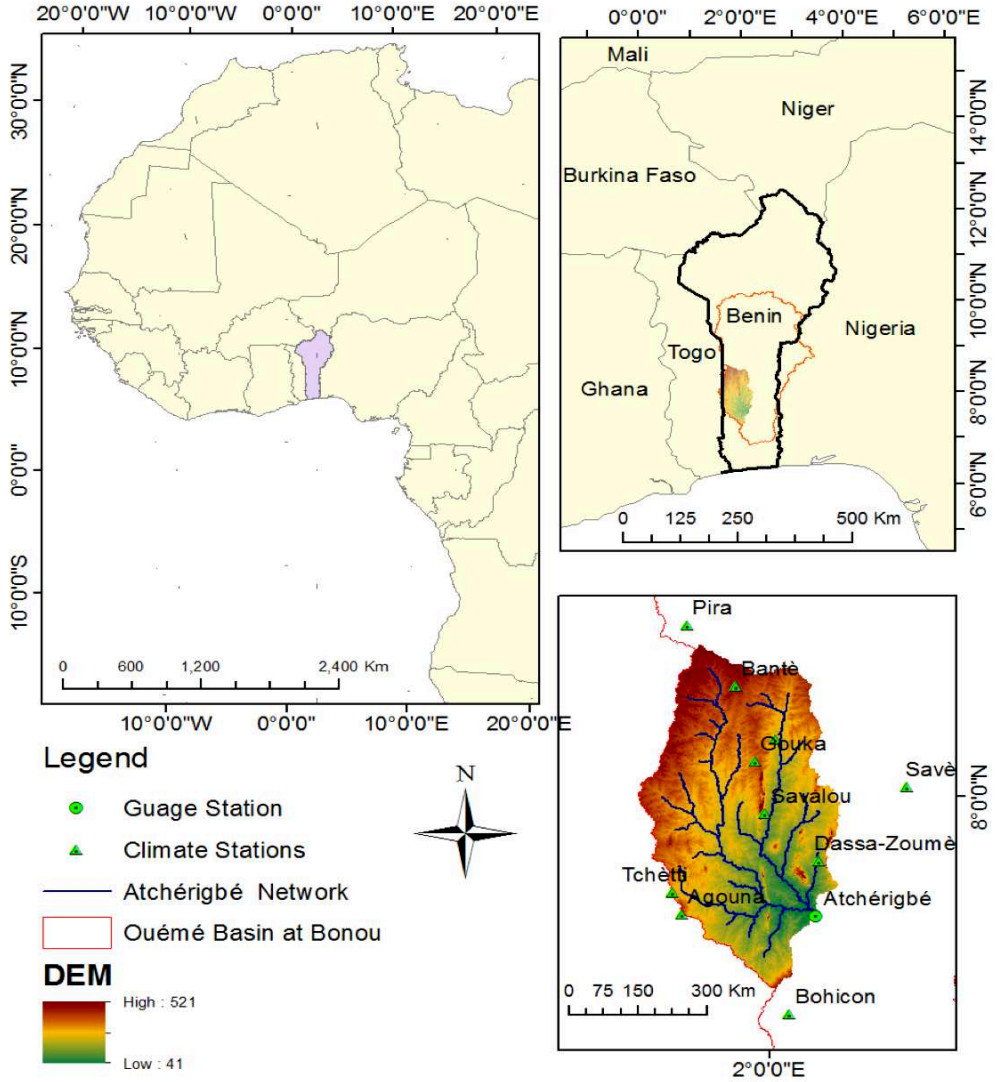
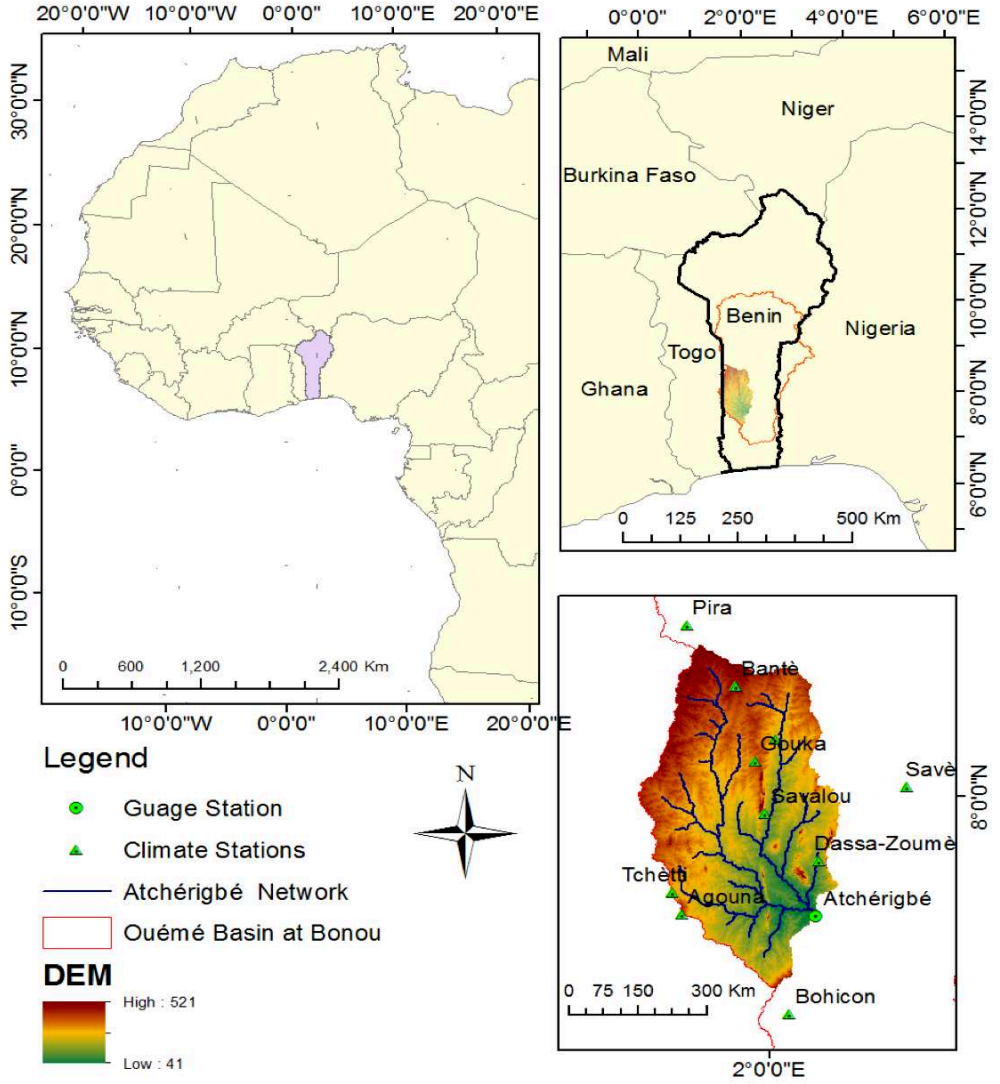


Data :

- Daily rainfall (ASECNA) and discharge data (DGEau)
- Geographical data (DEM, Soil, Land use)
- 2 socio-economic scenarios with three time horizons based on Rivertwin (2007).

Figure 7: Zou Catchment



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- **Major driver for LUC : population growth ⇒ subsequent conversion of the natural savannah vegetation into settlements, roads and a mosaic of fields.**
- Two socio-economic scenarios (LUA and LUB) were set up (Rivertwin, 2007 ; Götzinger, 2007) :

1. LUA : stronger economic development, controlled urbanization, 3.2% population growth per year ;
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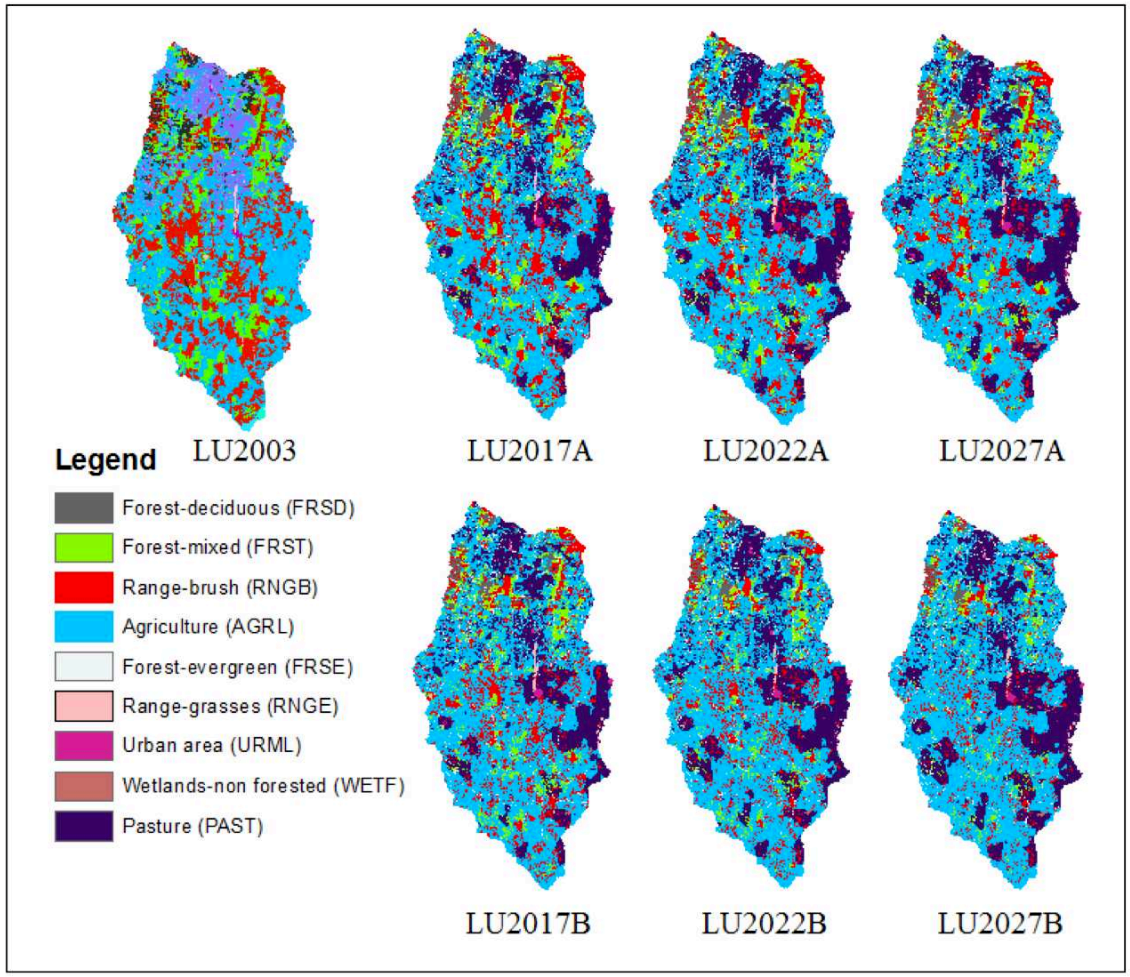

FIGURE 8: Land use map. (Data Source : Rivertwin (2007))

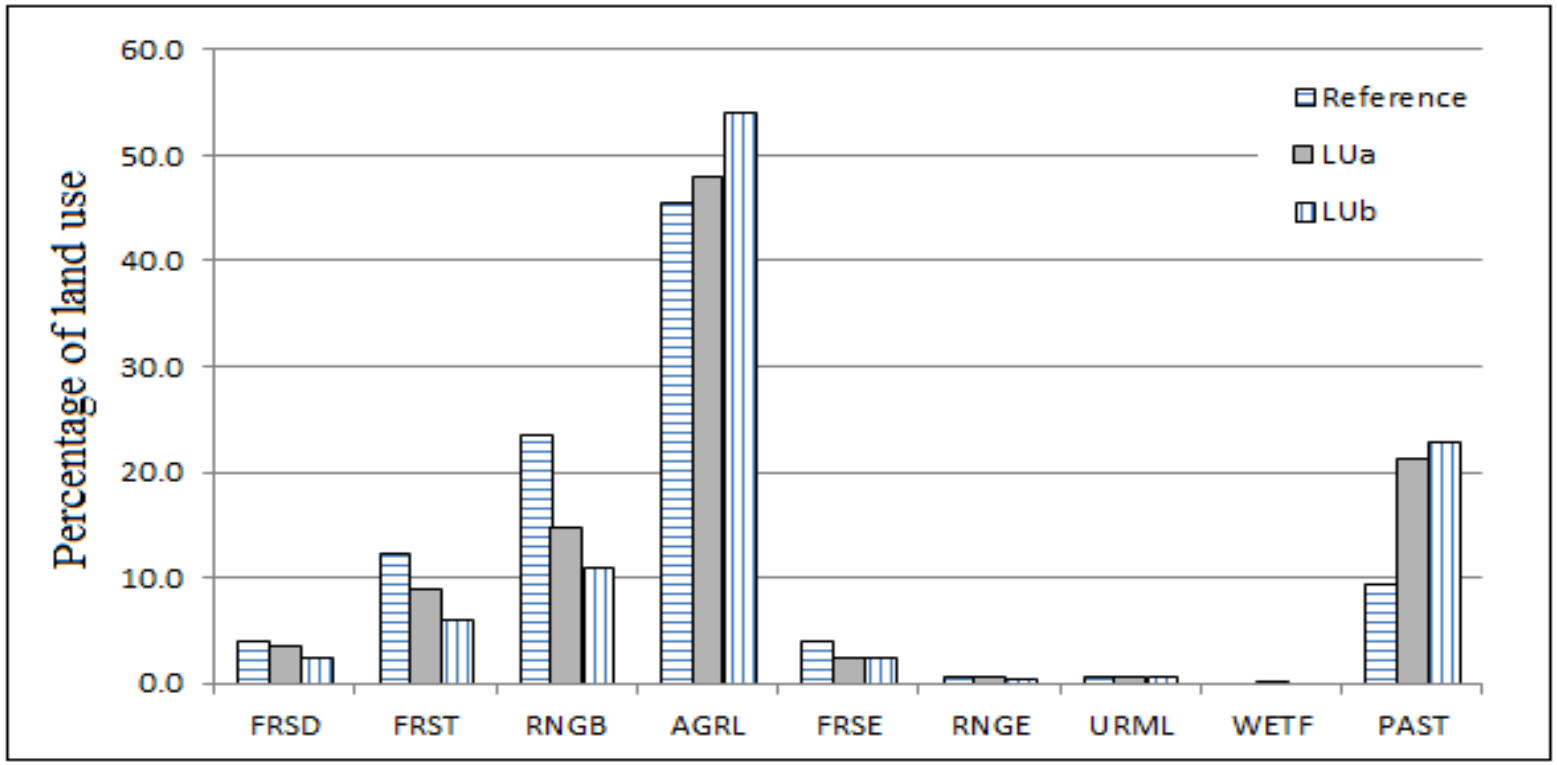

FIGURE 9: Change in land use scenario. The different land use types are forest-deciduous (FRSD), forest-mixed (FRST), range-bush (RNGB), agriculture (AGRI), forest-evergreen (FRSE), range-grasses (RNGE), urban area (URML), wetlands-forest (WETF), and pasture (PAST).

Hydrological models choice

- **For L.U.C impact studies, distributed and semi-distributed models can be used.**
- Advantages :

1. Ability of capturing the spatial distribution of input variables and physical parameters (land use, soil, elevation etc) ;
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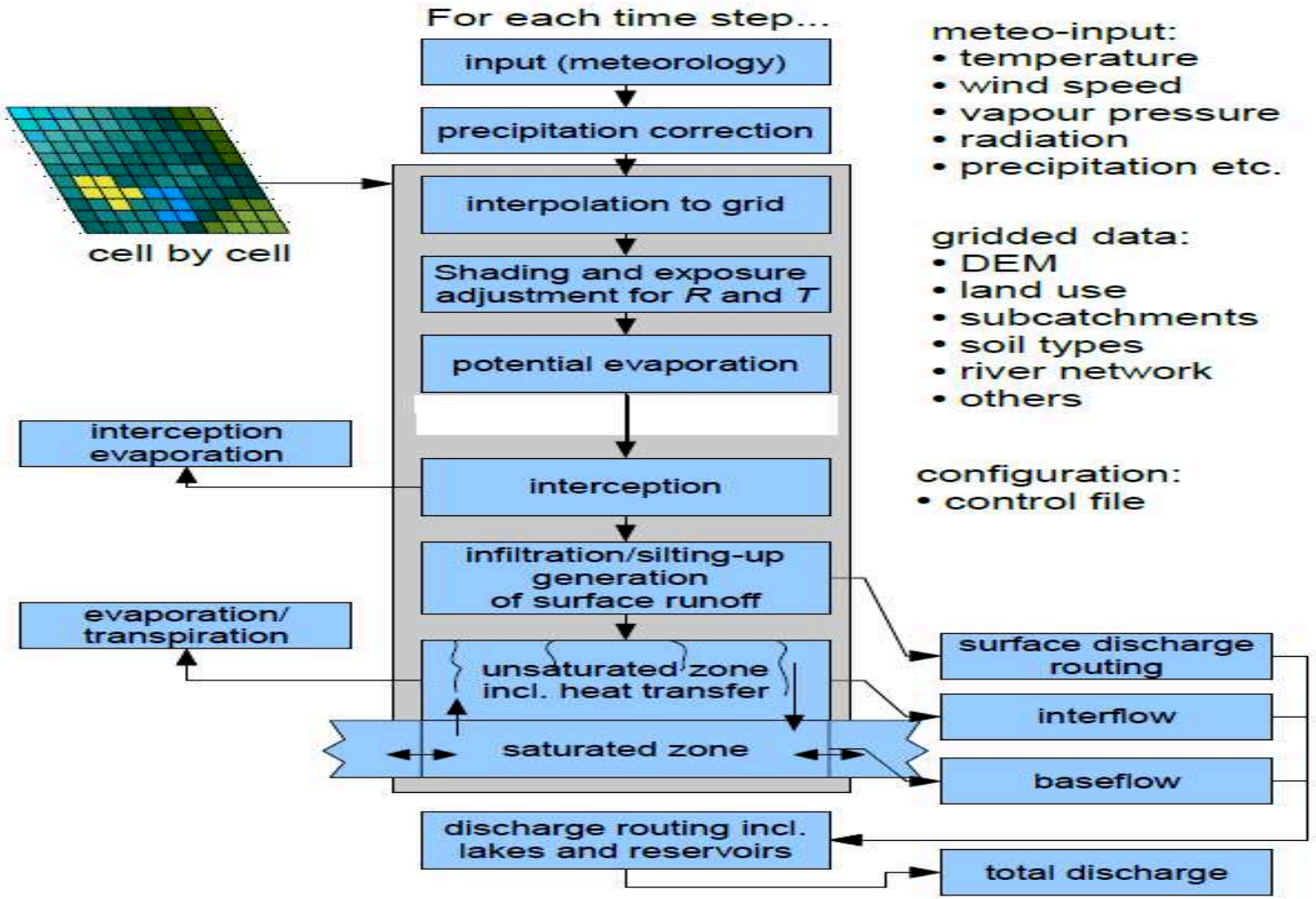

FIGURE 10: Brief description of WaSiM model (Schulla, 2012)

L.U.C. Impact on Flood Risk : Data and Methodology.

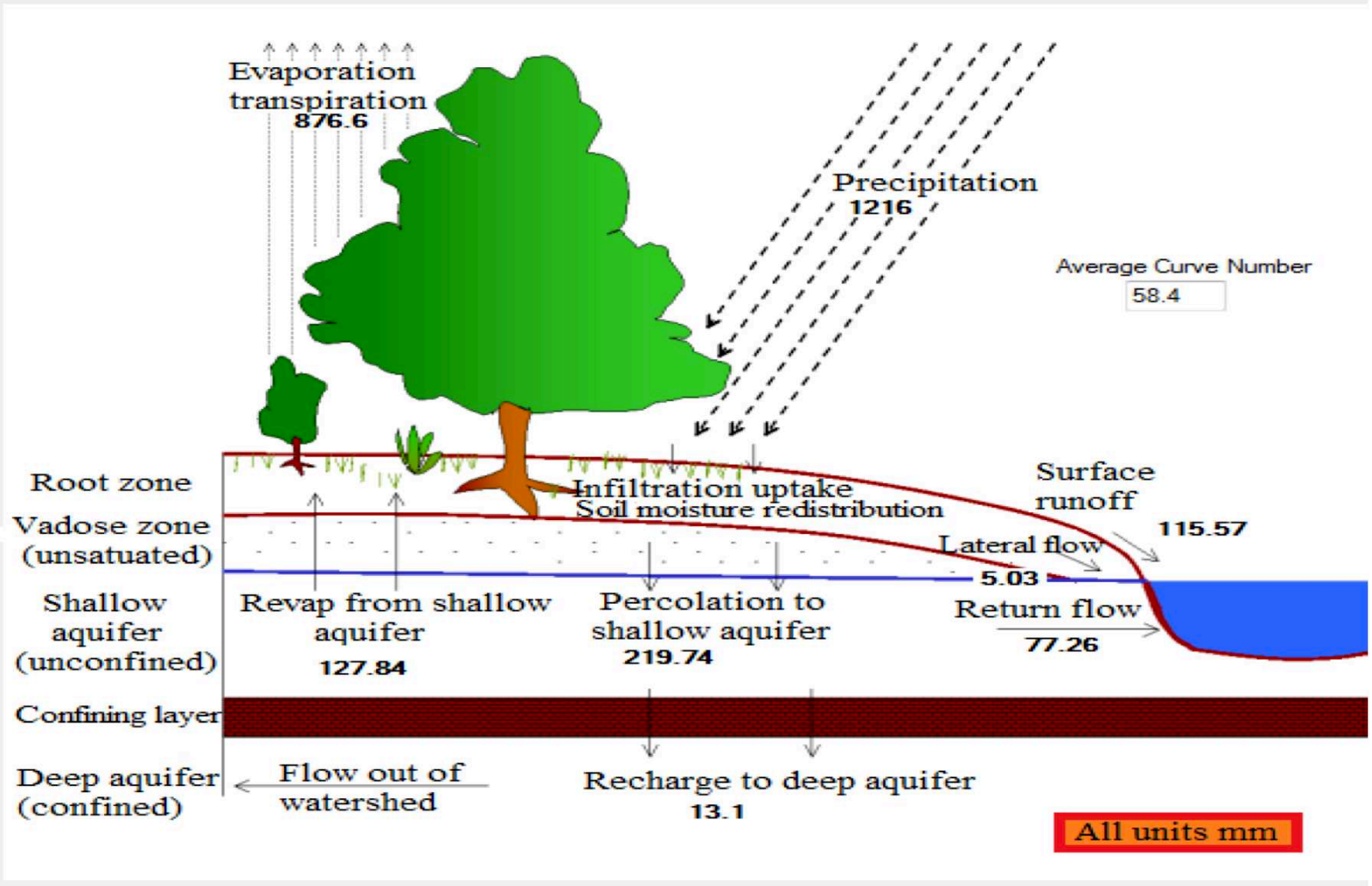

Figure 11: Brief description of SWAT model (Arnold et al., 1998)

Modelling steps :

1. **Hydrological models (WaSiM and SWAT) were calibrated and validated (KGE, NSE and APB).**
2. Two land use scenarios for three time horizons (2015-2019 ; 2020-2024 and 2025-2029) constructed based on the Rivertwin project.
3. Each hydrological model was applied to the two scenarios and three time horizons with ten best set of parameters. (2*3*10=60 realizations)
4. After extracting the discharges above $120 m^3/s$ for each of the 60 realizations, the Generalized Pareto distribution (GPD) was used for magnitude estimation and the Poisson distribution for frequency estimation.
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Calibration and Validation : SWAT & WaSiM

- **Satisfactory to very good simulations were obtained**

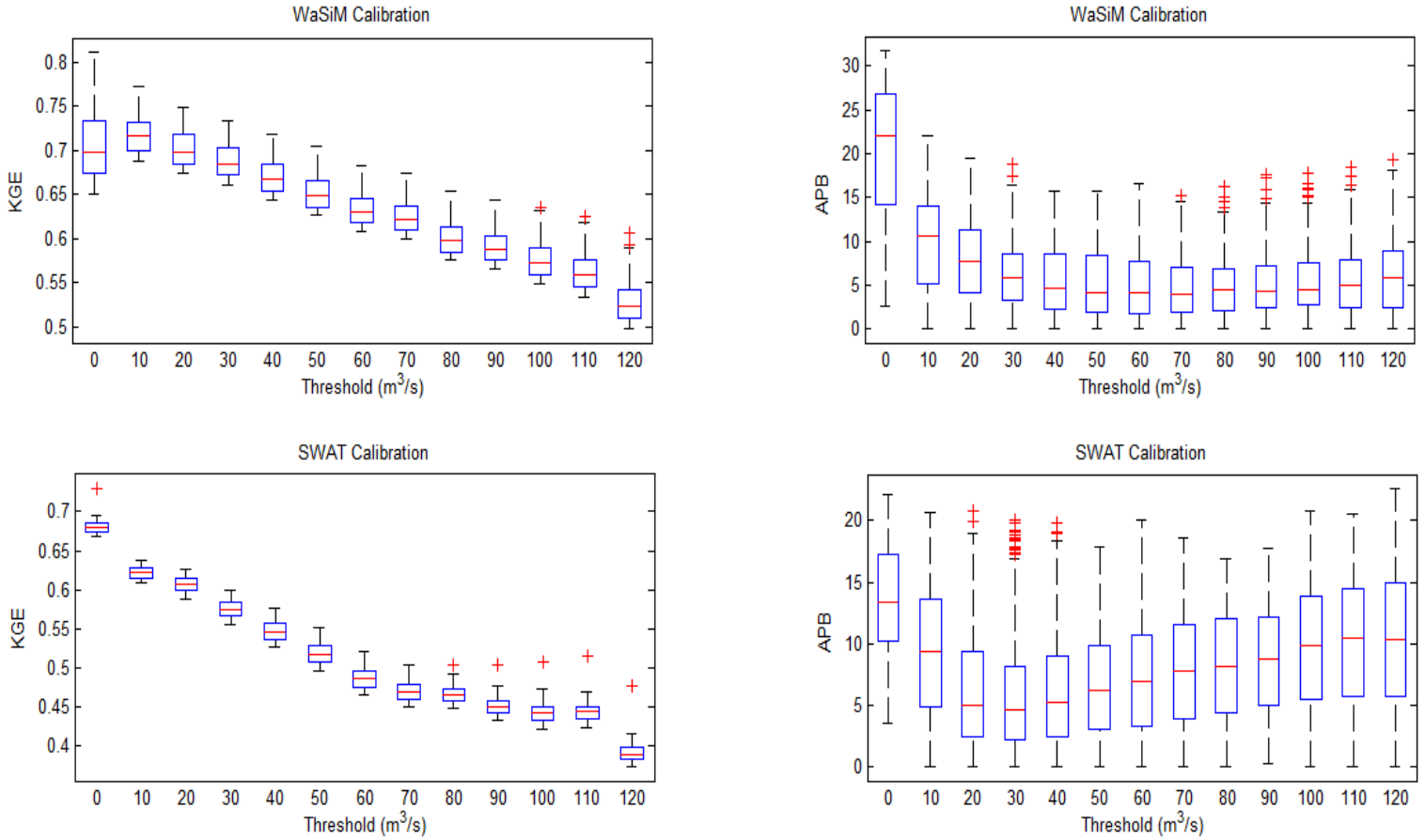

Figure 12: Model performances for different thresholds

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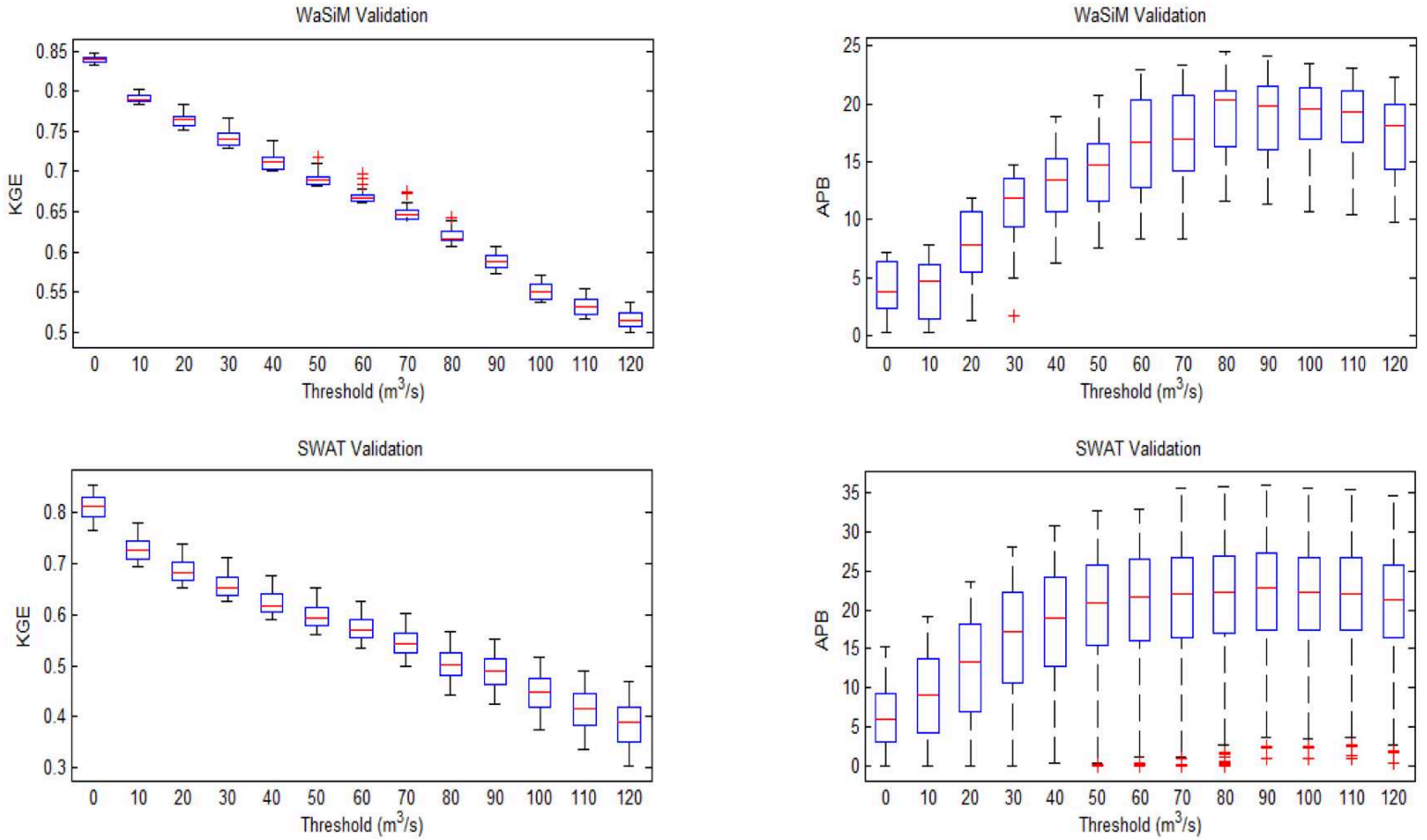

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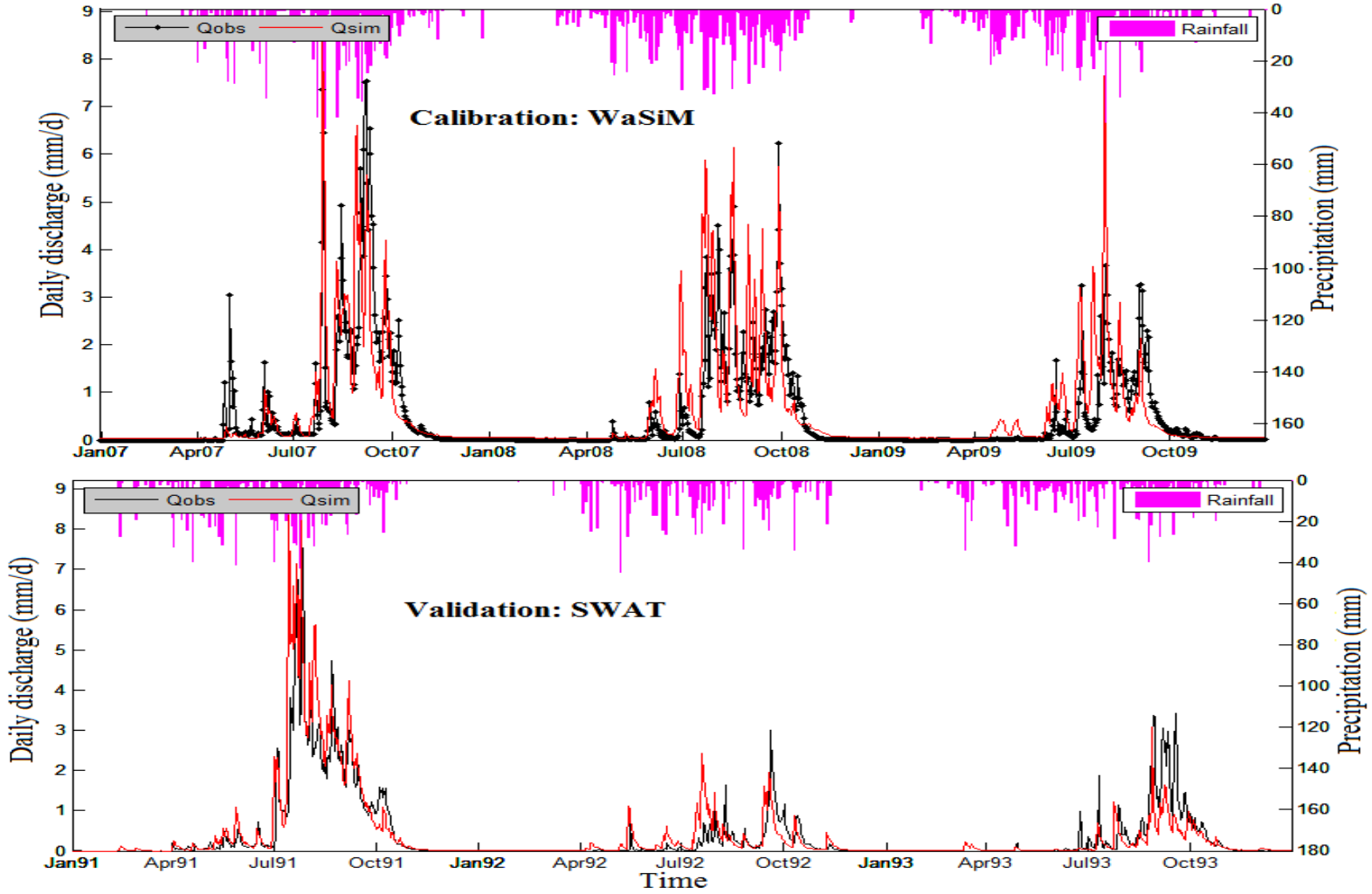

Figure 13: Observed and Simulated discharges

Change in quantiles projected

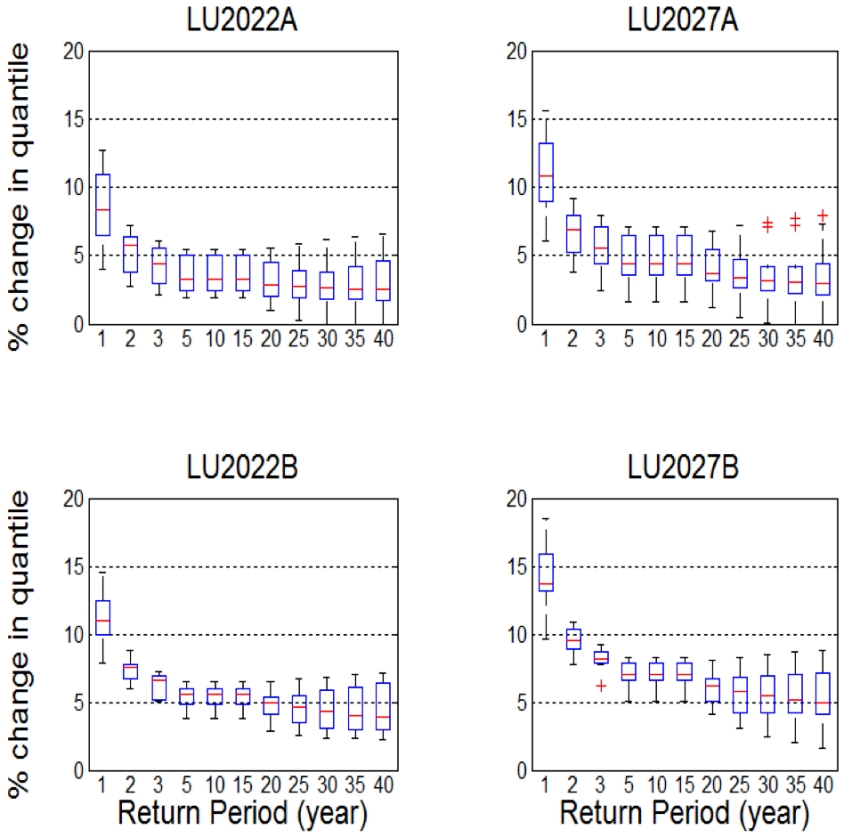

Figure 14: Percentage changes in x-year quantile as computed from WaSiM

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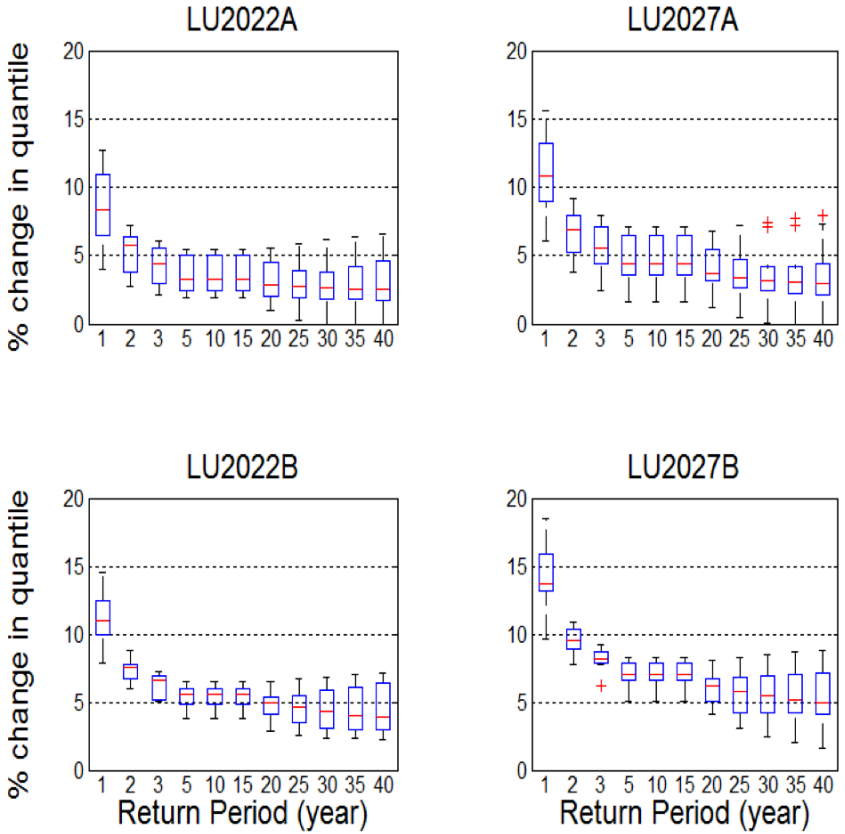

✓ **Both models for most return periods, agreed on the change direction, strengthening our confidence in the analyzed scenarios.**

✓ **According to the median, increased in magnitude of flood was simulated by both models based on the different scenarios.**

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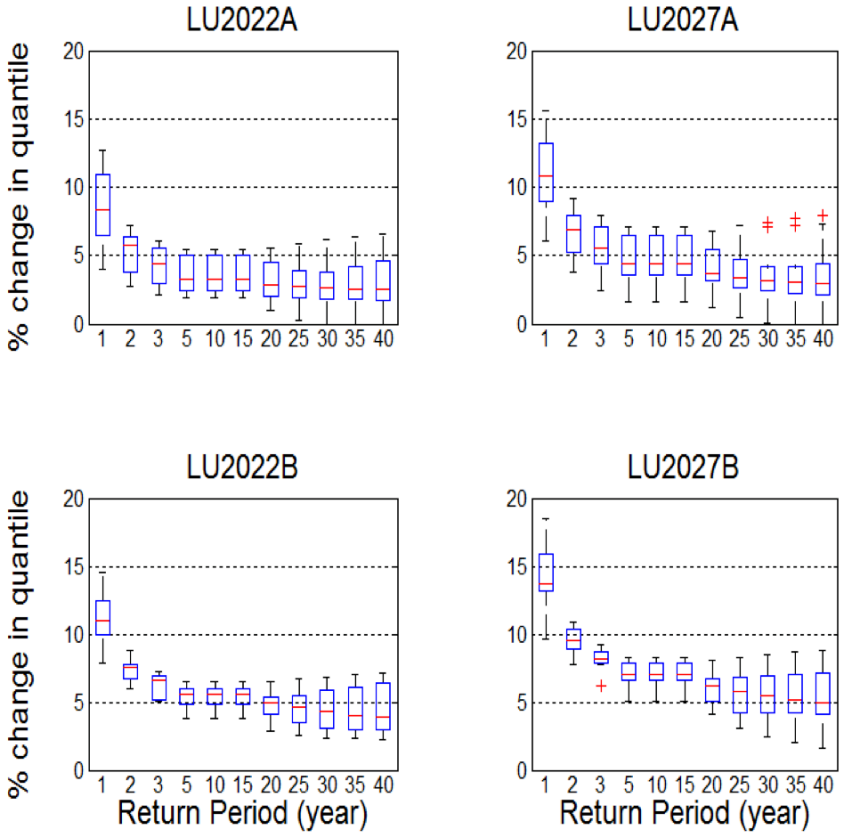

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✓ **According to the median, increased in magnitude of flood was simulated by both models based on the different scenarios.**

✓ **Changes were greatest for low return periods whatever the scenario and time window.**

New R.P. under different land use scenarios

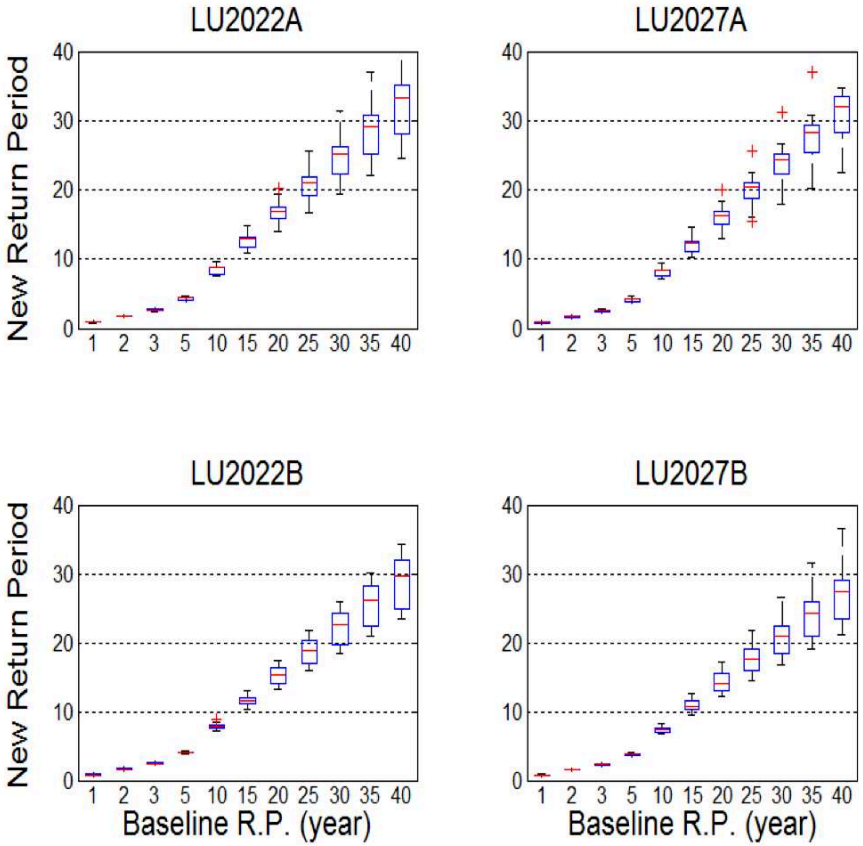

Figure 15: Baseline return period and the corresponding return period

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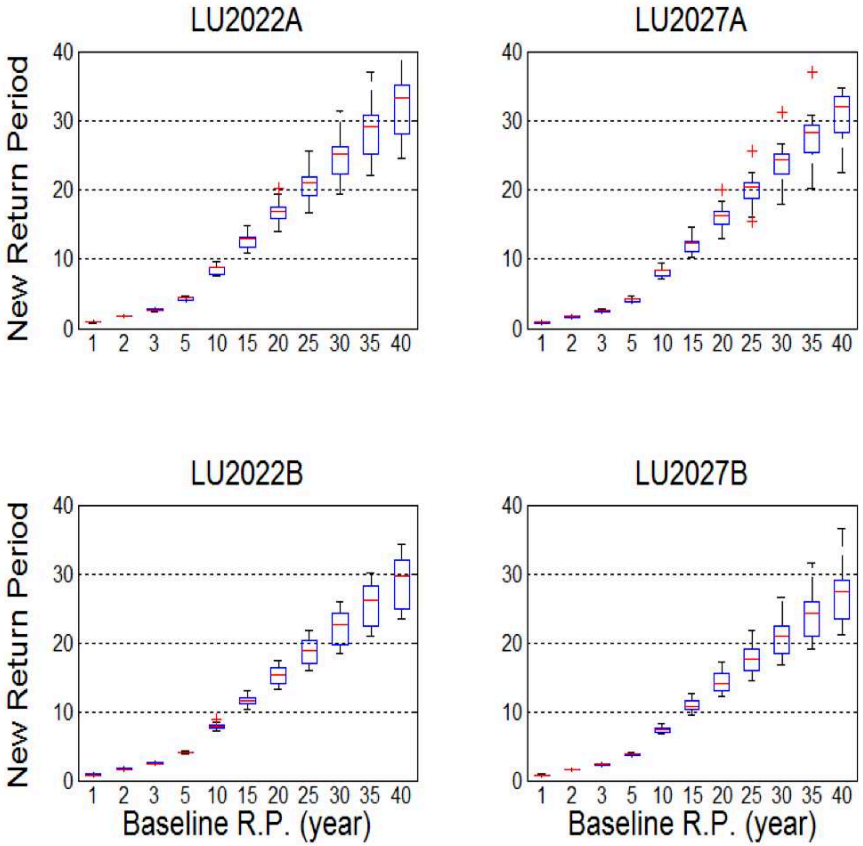

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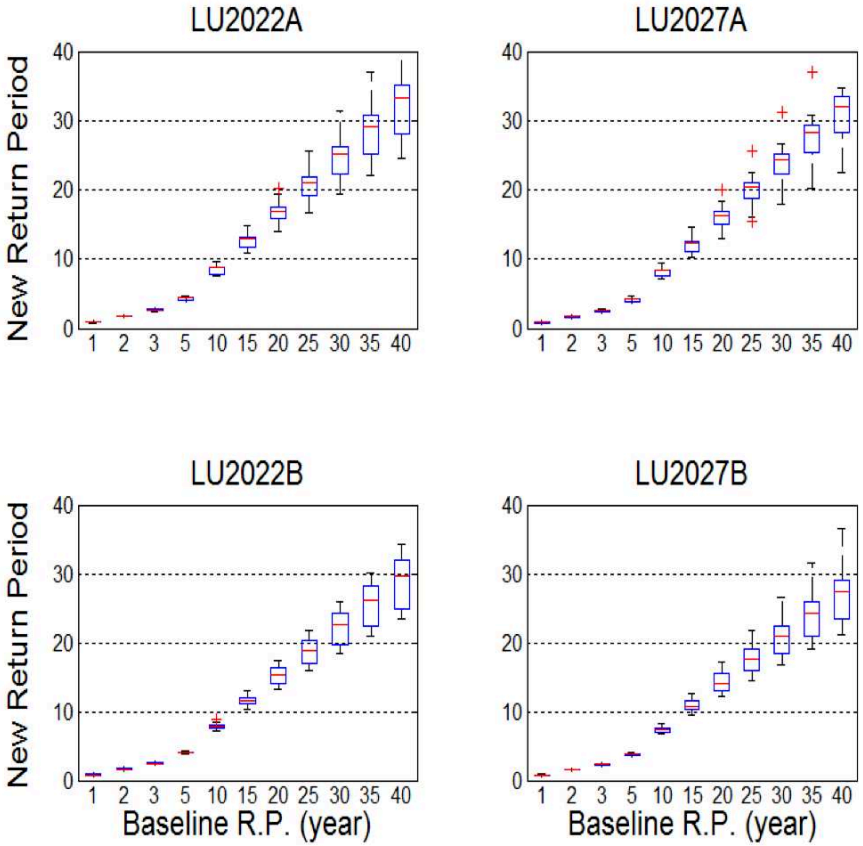

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✓ Between 7.0 and 9.4-year for a current 10-year event ;

✓ Between 13.1 and 18.0-year for a current 20-year event ;

✓ Between 23.4 and 35.6-year for a current 40-year event.

Relation between land use and floods

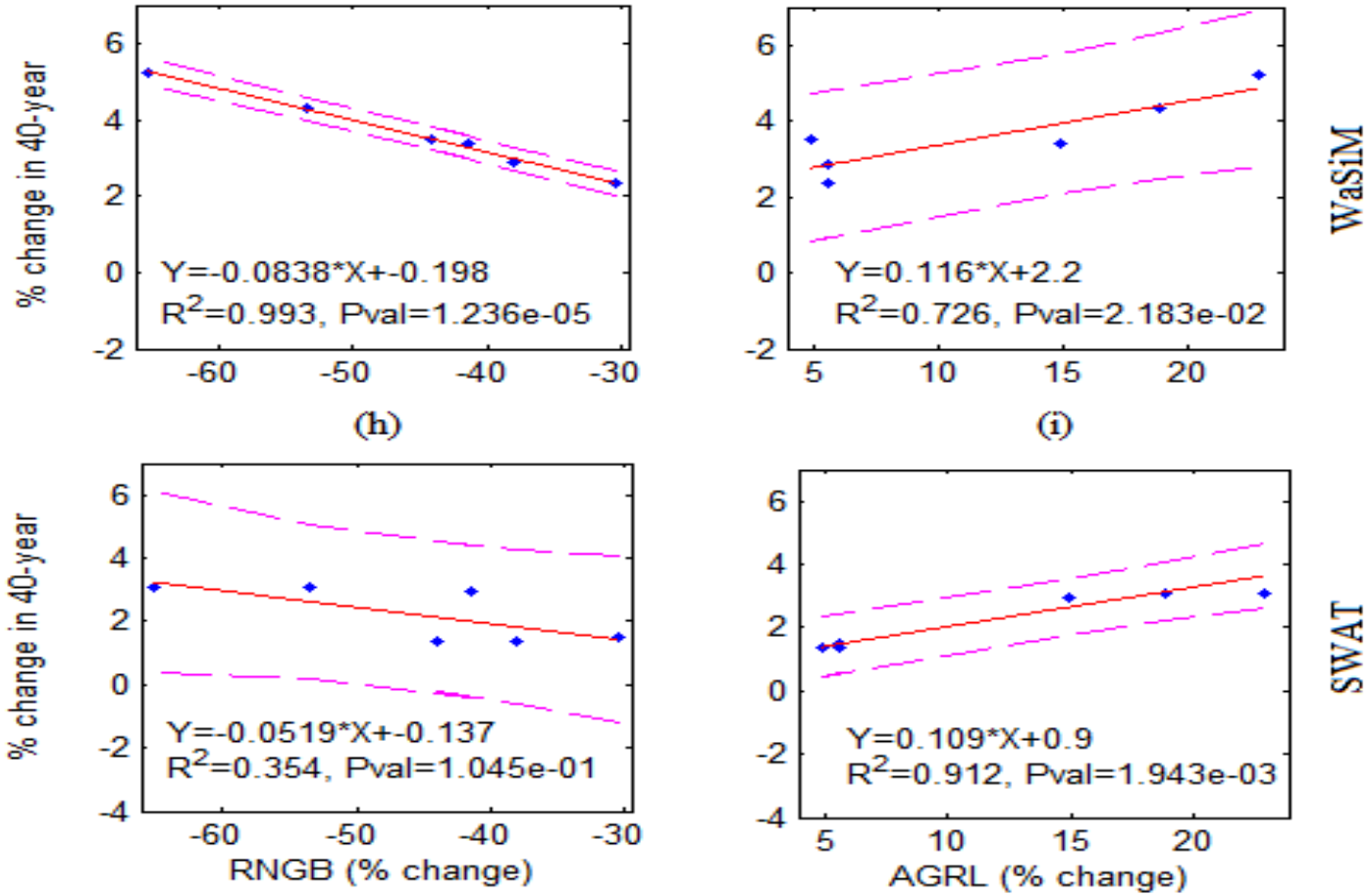

Figure 16: Change in 40-year quantile explained by the change in different land use types (% removed) by WaSiM and SWAT

Concluding Remarks . . .

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- **All models predicted an increase in flood frequency and severity for both scenarios.**
- **Flood risk will be even amplified if the rate of natural vegetation conversion to croplands and pastures increase to population growth rate of 3.5% as it was found in other basins.**

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- **Future studies based on combined effects of climate and land use changes on flood are required.**

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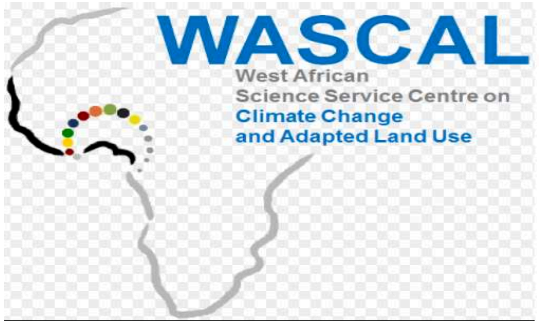

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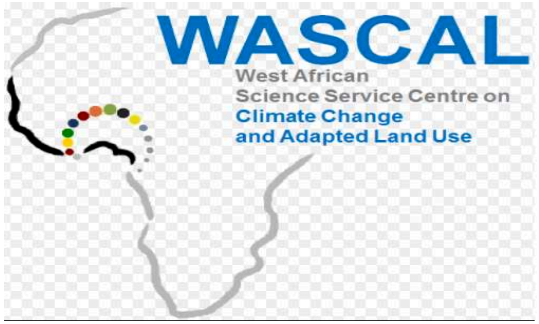

- **to ICTP for funding entirely my participation to this workshop.**

Thank you for listening.