Future flood hazard under climate change in the Mekong Delta

Heiko Apel (1), Nguyen Viet (2), José Miguel Delgado (1), and Bruno Merz (1)

(1) GFZ German Research Center for Geoscience, Section 5.4 Hydrology, Potsdam, Germany
(2) Southern Institute of Water Resources Research SIWRR, Ho Chi Minh City, Viet Nam
(hapel@gfz-potsdam.de, +49 3312881538)

GFZ Helmholtz Centre Potsdam

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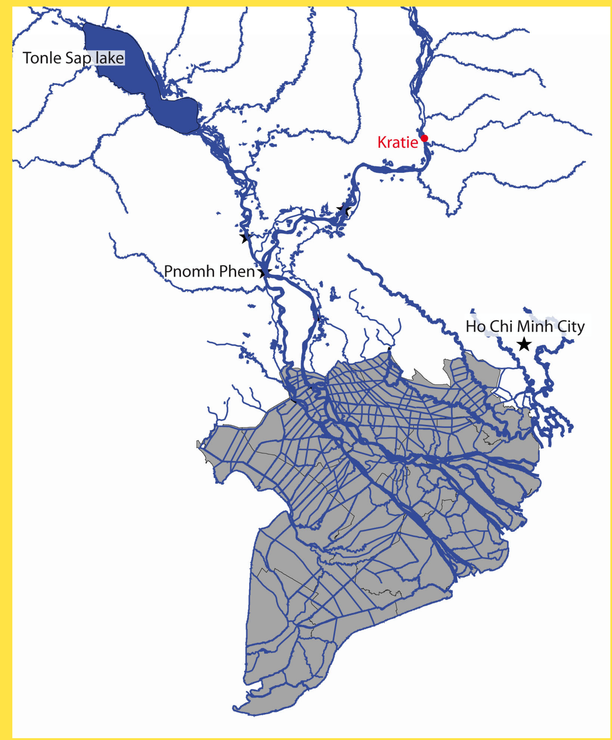
Abstract

Flood hazard analysis is an indispensable input for flood risk assessment. An essential part is the determination of probabilities of occurrence of floods of different magnitudes. However, the underlying assumption of stationarity does not hold for most of the observed discharge time series in general, and in particular not for future climate conditions. This is of particular importance for low lying coastal areas and estuaries like the **Mekong Delta**, which is on of the most vulnerable areas for climate change impacts worldwide.

This study aims at developing a novel approach for flood hazard mapping considering changes in climate variability. We explicitly take non-stationarity in the discharge time series into consideration and establish a **climate-flood link** for the estimation of future flood hazard. This approach utilizes identified **correlation** of **monsoon** indexes to **flood** magnitudes in the Lower Mekong, thereby **avoiding** the necessity of regional **downscaling of GCMs** and hydrological modelling.

Utilizing the output of 14 GCMs and a large scale hydraulic model, the **flood hazard** for the Mekong Delta in **2050** is estimated including **uncertainty** and visualized by **probabilistic** flood hazard **maps**.



The Mekong Delta (Vietnamese part in gray)

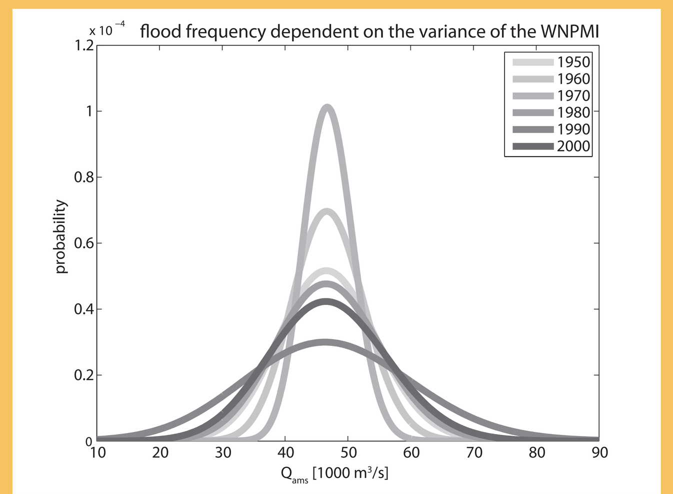
The Mekong river network and basin

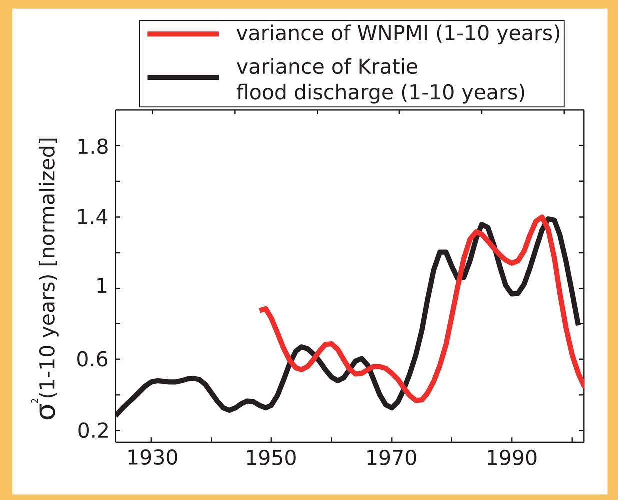
1. Flood peak & monsoon intensity

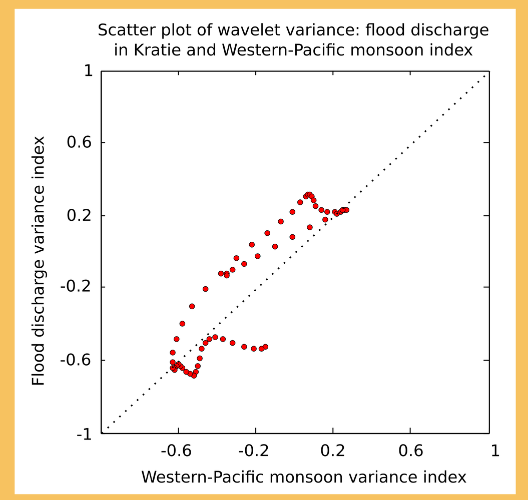
Delgado et al (2010) showed that annual maximum discharges (Q_{ams}) in the Lower Mekong are non-stationary and exhibit an increasing trend in variability.

The increased variability in Q_{ams} in the last two decades of the 20[st] century is also observed in the Western North-Pacific Monsoon index (WNPMI) (Delgado et al, 2011).

Following this, a linear relationship between variance in WNPMI and Q_{ams} frequency is established. I.e. the scale parameter of LN3 is directly estimated by WNPMI variance.

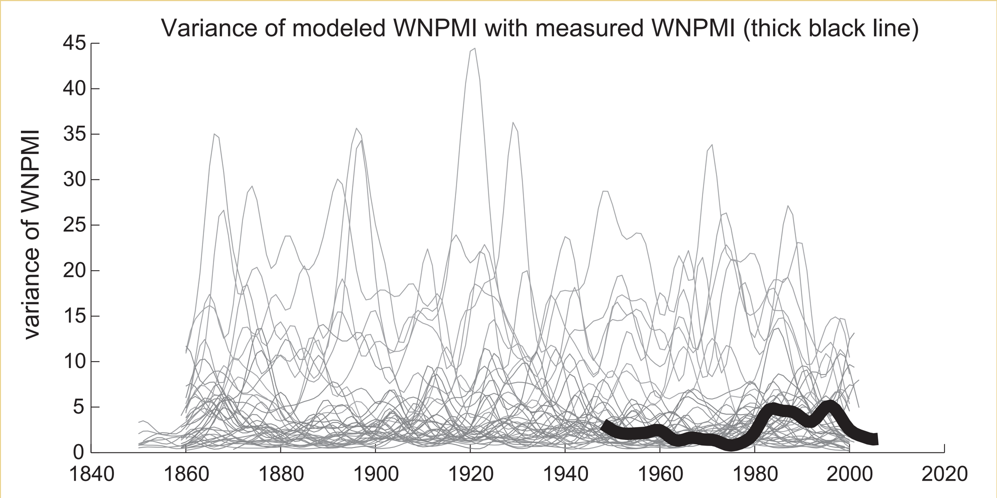






2. GCM monsoon skill

Testing the skill of different GCM realisations to model the WNPM by comparison with observed WNPMI variance.



a number of GCM's show poor skill in modeling WNPM variance.

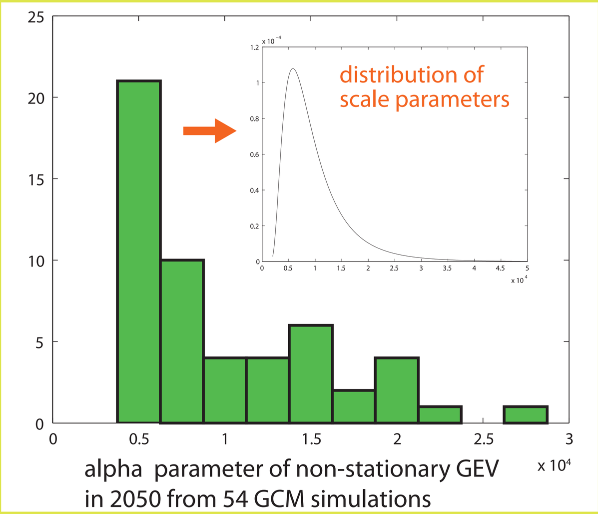
GCM acronym	p-value (< 0.05 excluded)	# runs per scenario: ENS. 20C	SRES A1B	SRES B1	SRES A2	ENS. E1
BCM2	0.9274	1	1	1	1	0
CNCM3	0.4507	5	0	0	0	0
CNCM33	0.0000	2	1	0	0	0
DMICM3	0.0010	2	0	0	0	2
DMIEH5	0.0010	1	1	0	0	0
DMIEH5C	0.0000	3	3	0	0	0
EGMAM2	0.0028	3	1	0	0	2
FUBEMA	0.0954	3	3	3	3	0
HADCM3C	0.1368	1	2	0	0	1
HADGEM	0.8036	6	1	0	1	0
HADGEM2	0.6025	1	3	0	0	2
INGVCE	0.1336	1	1	0	0	1
INGVSX	0.0000	1	1	0	1	0
IPCM4v2	0.1710	7	3	0	0	3
MPEH5C	0.0000	3	3	0	0	3

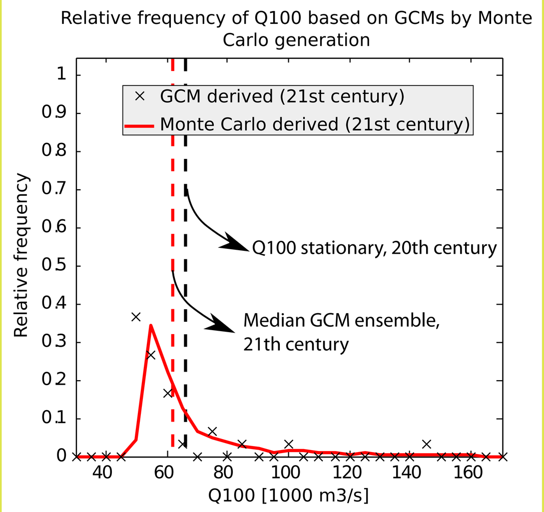
Exclusion of these models by non-parametric test for equality of variances: p-value of 0.05 as exclusion threshold (Lim and Loh, 1996).

3. Flood hazard projection

① Estimating scale parameter of non-stationary LN3 from GCM-derived WNPMI for 2050 (8 GCMs, 55 runs, ENSEMBLES project)

② Estimating T100 discharge in 2050 from a random set of scale parameters and non-stationary LN3 from step 1.





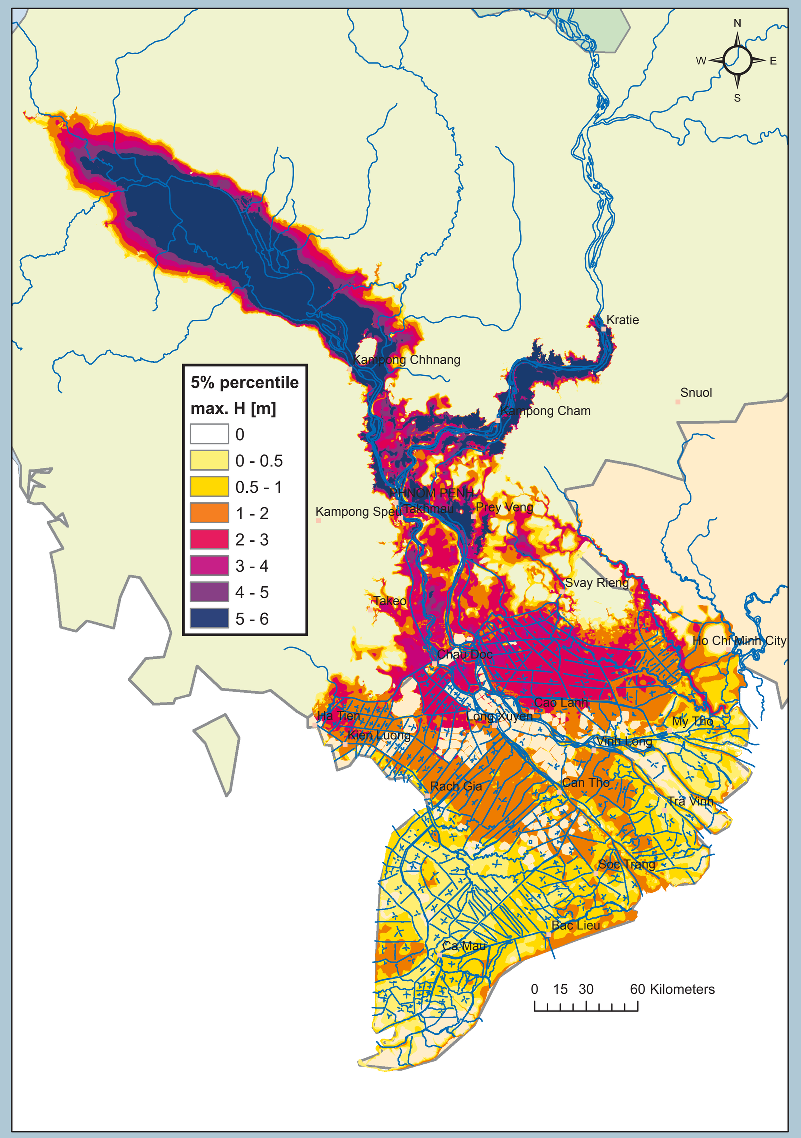
Q_{100} by different methods	Q_{100} [m^3/s]
stationary 2010, from observation	66594
non-stationary 2010, from observation	63856
non-stationary 2050 extrapolated from 2010	62572
non-stationary 2050 GCM median	60852

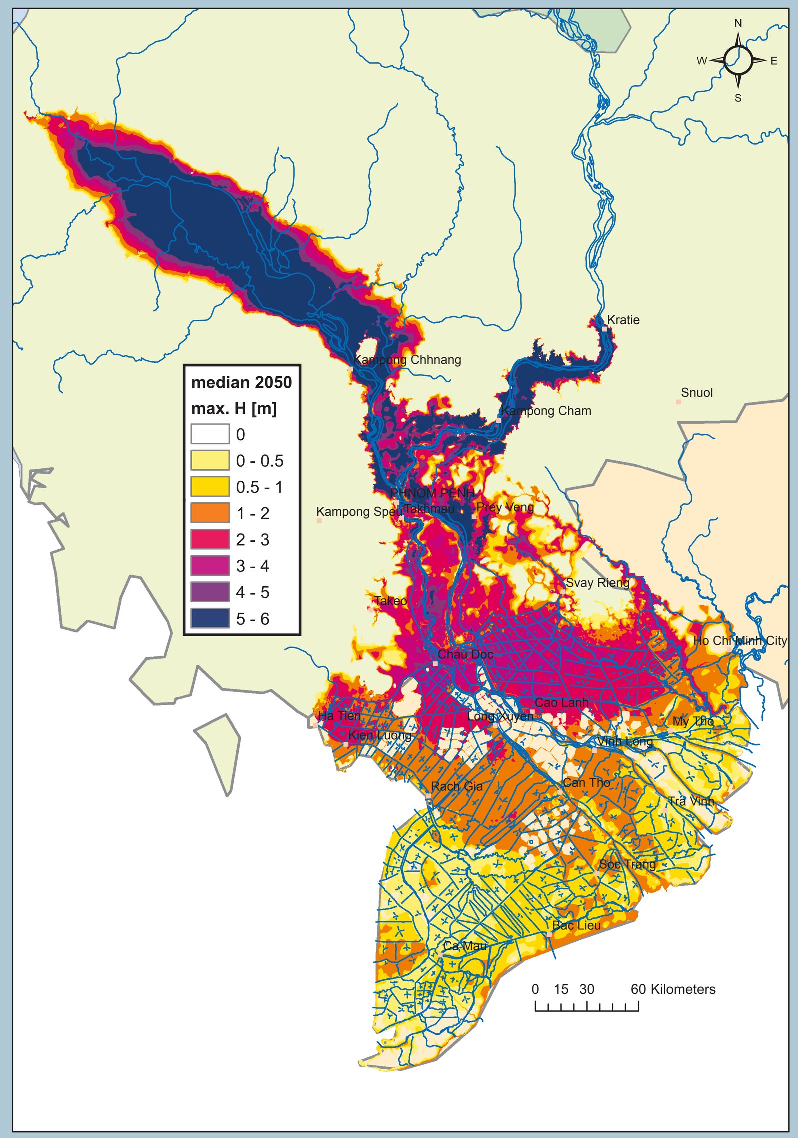
4. Flood hazard maps

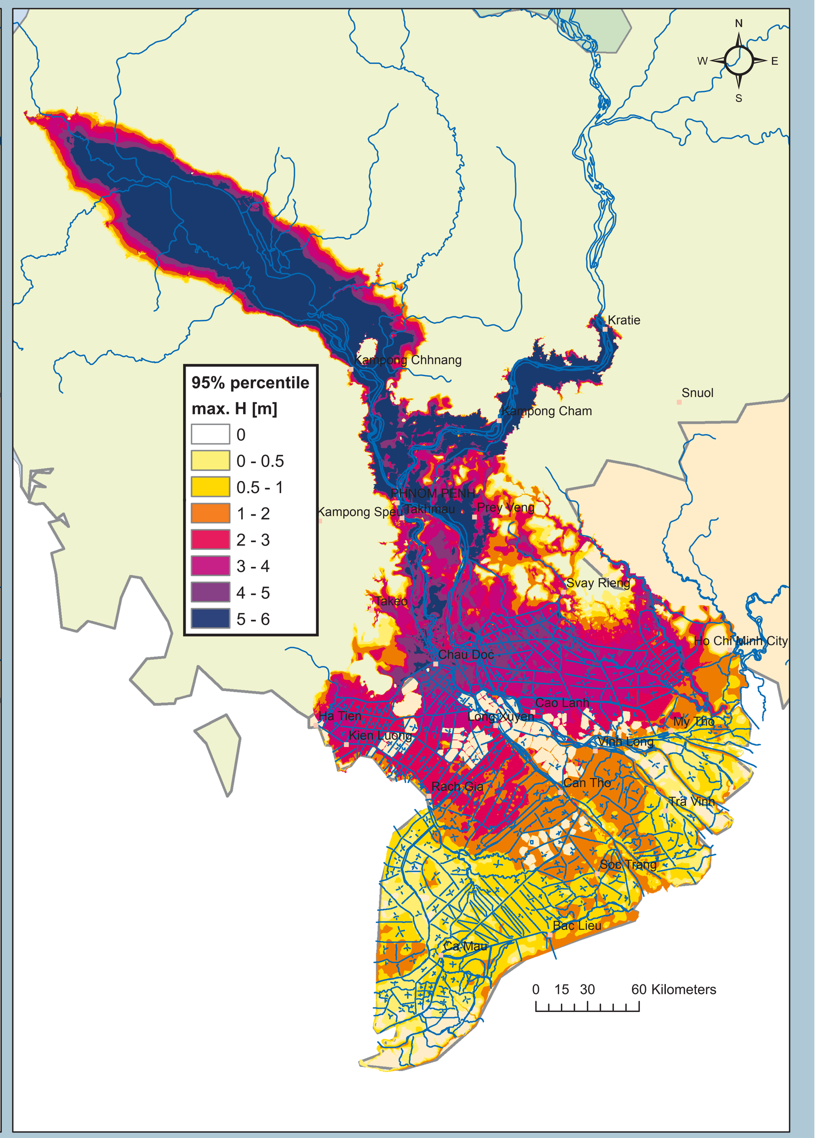
Using characteristic hydrographs, T100 discharges are scaled to synthetic flood events.

Simulation of inundation areas for 104 T100 flood events with large scale hydrodynamic model (Dung et al. 2011) and derivation of quantile maps of maximum inundation depths from scenario set.

Major inter-quantile difference in inundation depths, less in extent.







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