Co-evolutions Between Mega-cities' Development and the Vulnerability to Floods: Lessons from the Yangtze and the Yellow River

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August 2015

Context

○ **Territories stressed by floods**

○ **More and more urbanized world**

○ **Insights from China and two watersheds (among the world's biggest)**

○ **A multitude of megacities and dams are observed (used for protection or electricity generation)**

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Context

○ **Watersheds characteristics**

	Huang He (Yellow River)	Yangtse
Area (km²)	944,970	1,722,193
Population (millions)	189	420
Observed cities	9	7
Number of dams	10	89

Sources: WWF, World Resource Institute (2003).

Issue

○ **Watersheds are socio-ecological systems:**
human-beings and the environment interact (co-evolution)
(Gunderson & Holling 2002; Kallis & Norgaard 2010)

○ **Thus, natural disasters and urbanisation co-evolve**
(Pelling 2003; Adger 2006)

○ **Observations:**
- Population distribution disparities
- Widespread high density areas
- Downstream dams for protection, and upstream dams for hydropower

○ **How are people affected by floods?**

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Issues

○ **Evaluation of megacities' vulnerability to floods**

○ **Variations on the profile of risk is observed on:**
  - number of floods
  - type of impacts (deaths, affected, damages)

○ **What are linkages between megacities' structural characteristics and their vulnerability to floods?**

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Issue

Cities	River basin	Flood number	Death (ppl/flood.)	Affected (100k/flood	Damages (10k$/flood)
Baotou	Yellow River	6	132.33	50.10	36.63
Hohhot	Yellow River	6	132.33	50.10	36.63
Jinan, Shandong	Yellow River	12	129.33	152.99	77.99
Lanzhou	Yellow River	14	154.50	124.87	52.33
Luoyang	Yellow River	12	271.08	316.95	183.65
Taiyuan, Shanxi	Yellow River	7	621.29	372.28	241.90
Xi'an, Shaanxi	Yellow River	14	163.93	130.79	96.48
Xining	Yellow River	3	192.33	86.33	35.45
Yinchuan	Yellow River	5	115.60	51.80	21.27
Changsha, Hunan	Yangtse	39	425.00	347.29	239.08
Chengdu	Yangtse	32	607.81	341.14	232.59
Chongqing	Yangtse	32	607.81	341.14	232.59
Hefei	Yangtse	16	210.38	225.03	133.20
Nanchang	Yangtse	30	567.23	418.69	377.15
Nanjing, Jiangsu	Yangtse	12	500.25	626.22	362.16
Wuhan	Yangtse	31	639.48	409.80	289.12

Source: Bolognesi, 2015.

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Results

o **Base map shows land use**

o **Observations:**
   - Land use is non homogeneous within territory (infra and inter basins)
   - High density areas match with agricultural regions

o **The relation of human with its territories is an explanatory factor of vulnerability to floods**

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Results

o **Three explanatory factors** **(Bolognesi 2015)**

- **Maturity : city's development stage given national development (small dynamic cities, large stagnant cities, etc. within a given country)**

- **Anthropization : intensity of human land use and land transformation (natural area, agricultural area, etc.)**

- **Centrality : weight of the city in the country as a whole**

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Results

○ ## Factors values (Bolognesi 2014)

Cities	Maturity	Anthropization	Centrality
Baotou	-0.69	0.54	-1.12
Hohhot	-1.34	0.50	-1.20
Jinan, Shandong	-0.69	0.54	-1.12
Lanzhou	-0.69	0.54	-1.12
Luoyang	-1.02	0.52	-1.16
Taiyuan, Shanxi	-1.02	0.52	-1.16
Xi'an, Shaanxi	-0.69	0.54	-1.12
Xining	-1.34	0.50	-1.20
Yinchuan	-1.34	0.50	-1.20
Changsha, Hunan	-0.58	0.93	-0.98
Chengdu	-0.58	0.93	-0.98
Chongqing	-0.59	0.96	-0.64
Hefei	-0.58	0.93	-0.98
Nanchang	-0.58	0.93	-0.98
Nanjing, Jiangsu	-0.90	0.91	-1.02
Wuhan	-0.59	0.96	-0.64

Discussion

o **Diversity in type of impact**
  - **Each factor interacts on its own way with the variables of intensity of flood impact**
  - **There is no correlation between the variables of intensity of impacts**

o **Public policies have to be put in their context**
  - **Take into account the geographic and socio-economic territories**

o **Three characteristics to compare megacities worldwide**

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