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"Officina mi piace molto, consideratemi pure dei vostri"
Italo Calvino, lettera a Francesco Leonetti, 1953

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Water Scarcity

Dependencies and the definition of reciprocal relationships between territories and the mega-city

Dan Narita è dottorando in Urbanistica all'Università Iuav di Venezia.
e-mail: dan_narita@hotmail.com

Di fronte al problema della scarsità d'acqua, l'articolo esplora le potenziali multi-funzionalità delle reti idriche nei territori rurali. Dato che le attività economiche stanno gradualmente adottando gli approcci definiti dall'economia circolare, obiettivo del lavoro è quello di discutere diversi modi in cui le transazioni da urbano a rurale basate sull'acqua potrebbero essere più sostenibili e gestite in modo più efficace. Un caso di studio per questo tipo di interdipendenza territoriale è il bacino del fiume Dongjiang nel Guangdong, in Cina. Si tratta di una rete ecologica che comprende il delta del Pearl River e le sue mega-cities, il relativo hinterland e i corridoi industriali che si sono formati tra queste due parti.
Per promuovere un uso ecologicamente consapevole dell'acqua, nell'articolo sono proposte idee migliorative come l'introduzione di un sistema di idro-credito e come il regolamento di eco-compensazione volto a proteggere territori dallo sfruttamento e dal degrado ambientale. L'idea di monetizzare ulteriormente l'acqua, al pari di una merce, può infatti contribuire ad aumentare la consapevolezza della scarsità di questa risorsa esauribile. Ulteriori nuovi modi di commercializzazione potrebbero inoltre aggiungere valore alla multifunzionalità intrinseca delle reti idriche esistenti.

The commoditization of water as a tradable resource raises fundamental ethical and moral questions. In some parts of the world, the right of access to water has become a contentious issue, as opposed to being a basic entitlement. It is a resource affected by the *Tragedy of the Commons* (Hardin, 1968). Water depletion is one of the slow burning environmental stresses (Rodin, 2014). It is a serious impediment for securing resilience in distressed territories and new emerging cities. Protection of this natural capital has become critical. The question of ecological degradation and climate change, are a limiting factor for the environmental carrying capacity (Fang, 2015) for further urbanization of rural territories and the growth of mega-city regions.
In response to the issue of water scarcity, eco-compensation mechanisms (Zhang, Bennett, Kannan and Jin, 2010) and water trading systems are emerging (Hung and Shaw, 2005). Environmental resource credit systems try to curb further pollution and shortage of fresh and ground water. Some of the measures are the establishment of water quality trading markets and water purification environmental credit systems, gradually gaining acceptance in formal municipal administrations. Eco-compensation frameworks by the financial departments of provincial municipalities impose fees on the use of ecological services. Payments from beneficiaries of ecological services are collected in funds for ecological restoration and protection projects (Li and Liu, 2010). As China is undergoing large scale territorial transformations, it is necessary to explore alternative systems of natural resource sharing and re-distributions.
Settlements previously sustained by agriculture, forestry and fisheries, sacrifice land and water reservoirs for urban expansion and the creation of tourist destinations at the expense of

01

protecting their habitat and water networks. Natural capital such as water, soil, clean air and bio-diversity, become swallowed by rapidly growing cities driven by short-term economic objectives. There is a lack of consideration for the long-term, irreversible damages to eco-system services caused to ecological resources. Under reciprocal eco-compensation frameworks the main actors are the more wealthy urban municipal administrations consuming eco-system services and the lower-income farming communities supplying ecological services (Qiu-cheng, T.A.N., 2009). This type of framework regulates financial transfer programs for exchanges of environmental resources between them (Jun, Rongzi, Jingzhu and Hongbing, 2008).

In China, it is predominantly the underdeveloped, lower income agricultural communities and impoverished rural villages, which provide hydrological resources to metropolitan expansion for local government income, without taking into account the unintended consequences and negative externalities of urban development. To avoid compromising the integrity of common environmental resources and water pollution by rapid urbanization, the interests of territories for a future resilience need to be better protected. This may be achieved through the establishment of more carefully considered interdependencies between urbanized areas and rural territories.

Policies which would impose taxes and fees on resource extraction and water pollutant discharge (Jun, Rongzi, Jingzhu and Hongbing, 2008) by metropolitan areas, may reduce further environmental damage and give greater control to rural communities over the use of local natural resources.

Relationship of mega-city with its remote hinterland and in-between industrial corridors

Water consumption and pollution in Chinese mega-cities is amplified due to the growing urban population currently at 54%. The target of an urbanization rate of 70% by 2050 (Magnus, 2012), will cause further stresses on water demand and water pollution. Chinese economic growth driven by the development of cities, is supported by rural migrant workers being employed on construction sites for infrastructural, manufacturing and housing developments. Rural populations not only provide the labour to construct cities, but also become involved in water pollution generating activities negatively impacting their own water reservoirs in their rural hinterlands. While sacrificing their own environmental resources in the countryside, migrant workers in the city have no legal right to settle down in cities. Often they live in informal communities, lacking safe drinking water provision and basic sanitation.

Partly, urban expansion occurs through the exploitation of economically disadvantaged territories environmental resources.

> a water-based community where the water network and exchanges are actualized in multiple, different ways may cater for diversification, avoiding mono-functional land use and unfair transactional economies

It becomes an unequal relationship, in which rural populations give ecological resources to urban communities. Yet, in return they do not receive the same benefits as urbanites, while putting their own hydrological resources in the hinterland at risk. A more sustainable and equal use of resources would be to establish mutually favourable relationships for the use of water resources. Rural territories would need to better protect and monetize the supply of water to cities.

As mega-cities have economically benefitted from the ecosystem services of economically less developed territories, a change in the dynamics and the idea of "paying-back" by large cities to impoverished regions could to some extent counteract uneven development. In this sense greater awareness of the water scarcity issue would be raised. Rural territories will need to take measures to protect their hydrological assets from uncontrolled overuse, waste and contamination by more industrialized territories.

In anticipation of the continuing urbanization and overemphasis of a consumption-led economy, territories outside the larger urban agglomerations need to allocate financial reserves and sources of income for wastewater treatment and purification facilities.

Dongjiang River Basin: a main source for the Pearl River Delta

The Dongjiang River Basin in Guangdong province has a critical function for the Pearl River Delta urban agglomeration, home to approximately 120 Million people. The greater Megacity cluster includes eleven cities: Guangzhou, Shenzhen, Zhuhai, Dongguan, Zhongshan, Foshan, Huizhou, Jiangmen and Zhaoqing, Hong Kong and Macau. All cities have competing water consumption needs and economic interests. Additionally, there are economically less developed in-between territories (Viganò, 2015) also depending on environmental resources. Townships and village communities heavily rely on the water resources in terms of economic income and livelihood. As an example, the Dongjiang River water supply system supplies up to 80% of Hong Kong's water demand supplemented by additional supply from the Xijiang River (Xu, 2014) and the Jiangxi province (Su, 2012). Within a time frame of 50 years the water demand for the downstream Hong Kong region has multiplied by approximately thirty-five times (Xu, 2014).

The economically disadvantaged upstream territories, however, have not benefitted from the Special Administrative Region's economic growth in since early 70's. As a comparison, the average per capita GDP in Hong Kong is 29,90 USD and only 290 USD in Xunwu upstream of the Dongjiang River Basin bordering Jiangxi province (Lo, 2010). In terms of geographic distance, the major water consuming cities cluster of Hong Kong, Guangzhou and Shenzhen are approximately 250 km away from the hinterland of this urban agglomeration. The remote sites of water supply and reservoirs also tend to suffer from water contamination not only from agricultural runoff, but also from industrial land use of manufacturing plants. As soon as there are economic fluctuations or a downturn, the manufacturing plants abandon the industrial sites, and leave behind the environmental pollution caused.

For economically deprived territories to fund adequate wastewater treatment facilities and management of water supply systems, successful eco-compensation mechanisms were established in 2012. Ecosystem Compensation Fund subsidies from the developed downstream Pearl River Delta are being transferred to upstream to ecological control areas and for water resource protection. The municipality of Shenzhen in the Pearl River Delta is making compensation payments of 500 Yuan/month per capita to communities in upstream Dapeng, Kuichong and Nan'ao for environmental protection. Further incentives in place for adopting environmentally friendly economic activities are the increase of pollutant discharge fees to a level where sustainable emission management becomes the more economical option (Zhang, Bennett, Kannan and Jin, 2010).

Multi-functionality of hydrological networks

To enhance the resilience of disadvantaged territories, it is crucial to assess the inherent multi-functionality of its hydrological networks and water reservoir assets. For the multi-functionality of river networks to be a key framework for liability

02

and well-being, it is necessary to maximize its environmental positive externalities, and to engender the compound benefits in a sustainable and future-proof manner. Given the ruptures and disintegrations of territories as a result of the fast urbanization process, a strategic reinstatement of continuity in an ecological network in which water is the currency is required. Further multiple functions and services supplied by water resources need to be monetized to generate funds for ecological remediation.

A water-based community where the water network and exchanges are actualized in multiple, different ways may cater for diversification, avoiding mono-functional land use and unfair transactional economies. The idea of multi-functionality for hydrological networks is derived from the concept of multifunctional landscapes (Brandt and Vejre, 2004). As such landscapes can carry agricultural, forestry, wildlife, renewable energy, recreation, transport and defense related functional capacities.

The five key categories related to the multi-functionality of water networks can be summarized as follows: systems of production include the provision of food, clean energy and materials. Environmental assets in addition to water are air, soil, habitat and land use. Economic opportunities are the diversification of income, creation of employment, as well as remote retailing and on-line trading of agricultural produce. Welfare benefits, which can be actualized are health&well-being, housing, education, governance&administration, culture and traditions. Some of the eco-system services potentials are: absorption of pollution, system stability, flexibility, regeneration, recreation and resistance.

The idea of simultaneous functions seeks to combine physical and commodified exchanges derived from water networks for the benefit of the remote, dispersed settlements. In its broadest sense, further elaboration of the concept of multi-functional water networks gives opportunities to build-in resilience for distressed and disadvantaged territories in crisis.

Water as a shared resource and circular exchange system

A collaborative approach to water consumption, reuse and recovery would enable a more responsible approach to this issue of water scarcity. The concept of the circular economy suggests a closed loop use of resources (Stahel, 2016). The idea of the circular economy entails optimized industrial processes that would minimize the waste of natural resources (Graedel, 1996). To avoid unnecessary recourse to yet unspoiled water reservoirs in remote territories, purification of grey water and reduction of industrial discharge must be prioritized.

Further, the extraction of waste and pollution, could become

> mega-cities have economically benefitted from the eco-system services of economically less developed territories

part of the cycle of the resource reuse. Biomass found in water networks and excessive algae growth caused by pollution would be utilized and converted into biofuel to provide for renewable sources of energy to local communities. As a way to upscale water decontamination and the reuse of biomass for energy generation, such biomass waste could be used to run water treatment plants to close the resource use circle. This may reduce the dependence on fossil fuel based sources of energy to operate water purification facilities.

Communities and companies, adopting a circular system of water resource reuse and recovery would be incentivized. By avoiding waste and reducing water pollution people and industries would be rewarded with hydro-credits. Water credits can then be exchanged between companies and municipalities. A company, generating excessive water contamination or has an overuse of water, by policy would be ordered to reduce the discharge of toxins in waste water. Companies and individuals may purchase hydro-credits from each other as a tradeable commodity. Part of a circular approach to sustainable water consumption would be to internalize negative externalities into the economic equation of ecological conservation by implementing eco-compensation mechanisms (Yu and Ren, 2007). This would generate additional funding for ecological restoration and protection.

Temporarily, companies which are polluting water at unacceptable levels can off-set costly fines by purchasing water credits from more eco-conscious companies. Policies would need to be in place to keep water pollution fines and penalties higher than the cost of installing water purification facilities in manufacturing plants and companies. In this way a hydro-credit trading system could be established giving the incentive to purify water and to instill an environmentally friendly consumption of water. If the taxation of water contamination is rigorously maintained throughout political cycles and changing government administrations, then gradually responsible and resourceful use of water would be adopted by the industries and the society.

Conclusion

The research into rural to urban interactions is predominantly studied from the perspective of networks formed by urban-rural interdependencies. Hydrological networks are the lifeblood binding the rural and urban territories together. The complex linkages between rural and urban territories are becoming increasingly detached from settlement spaces for people and ecological territories. The opportunities for redefining the hydro-networks into transformational linkages between rural-to-urban territories themselves are not yet fully explored and thus, require more research. Linkages and strands forming the networks between territories must be designed to be multi-functional to enhance the resilience of remote territories. A more sustainable and equal use of resources would be to establish mutually beneficial relationships for the use of water.

For rural territories heavily depending on their hydrological networks, their social and economic exchanges may be actualized in multiple, different ways catering for a better economic diversification. Some of the measures are the establishment of water quality trading markets, water purification credits and eco-compensation mechanisms. Communities and companies, adopting a circular resource use and eco-compensation financial transfers (Stahel, 2016) would over time become environmentally more resilient. By avoiding waste and reducing water pollution people and entities would be rewarded with hydro-credits. Such water credits could then be exchanged between companies and municipalities. Gradually, this may lead to a positive transformation towards a more responsible use of water.▲

IMMAGINI

01 - View into Victoria Harbor in Hong Kong. Dongjiang River is a key water resource for this for the Special Administrative Region in the Pearl River Delta. The City benefits from resources in less developed neighbouring territories. Credits: Songquan Deng.
02 - Industrial wastewater discharged into the river. Under a hydro-trading system environmentally unfriendly companies will need to acquire hydro-credits from businesses with more sustainable production processes. Credits: Daizuo Xin.
03 - The multi-functionality of landscapes and hydrological networks needs to be protected and its potentials capitalized in an ecologically friendly manner to secure long-term resilience. Credits: Carst Hets.

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