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Perspective

Recalibrating China's environmental policy: The next 10 years

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ABSTRACT

Just after its once-a-decade leadership transition, China faces the cumulative consequences of the 30-year drive to grow its economy with scant attention paid to mounting ecological and social costs. A survey of six main stressors in China – ecosystem degradation, food security, energy, water, urbanization and climate change – reveals that domestic environmental policies are inadequate and need to be reformed. China's ecosystems remain subject to widespread degradation and food insecurity is increasing. There are growing conflicts over water quality and quantity, and energy demand is rising rapidly. Urbanization is set to power future growth in China, yet sustainable urban planning cannot proceed without fundamental environmental and social policy reforms. Climate change is already negatively impacting China and is projected to grow in strength. China's new leaders must act soon to recalibrate environmental policies across all these sectors. In addition, they must address the lack of interdisciplinary problem-framing and gaps between central government policy and local level implementation. While many sectoral solutions are already in progress, over the next decade and beyond, institutional reform across the country's social–ecological systems will be key to solving China's environmental problems.

Contents

1. Introduction

In 2013, as China ushered in its once-a-decade leadership transition to new President Xi Jinping and Prime Minister Li Keqiang, the country stands at a critical crossroads. The economy has slowed and both domestic and international experts are calling for a broad transition away from the export-led growth that has made China the world's second-largest power (The World Bank and Development Research Center of the State Council, 2012). Concurrently, China faces the cumulative consequences of its 30-year focus on economic growth with scant attention paid to mounting ecological and social costs. In January 2013, citizen outrage over Beijing's hazardous air quality served as a tipping point for the central government to act and, since then, environmental problems have been featured prominently in the media and been discussed widely (Wu et al., 2013). The government has already made legally binding commitments to reduce national carbon intensity, increase

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the use of non-fossil fuels and expand forests. Yet there is little interdisciplinary problem-framing to address the lack of policy connections within and across China's social–ecological systems (United Nations and Asian Development Bank, 2012). (A social–ecological framework accounts for the links between resources, people and governance systems (see Ostrom (2009)). At the national level, ministerial actions often lack coordination and officials often do not have the capacity to enforce regulations. There are disconnects between central and local decision making; at local levels, Beijing's edicts are subject to "bureaupreneur" behavior where officials often act contrary to central government mandates resulting in poor policy implementation (Hillman, 2010). With environmental problems now openly acknowledged but solutions still far off, and already-unprecedented urbanization rates gaining speed, the next decade will likely determine the future trajectory of China's rise. A brief overview of six main stressors – ecosystem degradation, food security, energy, water, urbanization and climate change – shows that Xi and Li must act soon to recalibrate the nation's environmental policies to meet growing resource demands and uncertainties.

2. Ecosystem degradation

Despite extensive restoration efforts and huge amounts of funding, China's ecosystems remain subject to ongoing degradation (Lu et al., 2011). For example, though there have been large increases in forest cover, only about 11% of China's forests have good ecological functioning (Department of Forest Resources Management, 2010). There has been a logging ban in place in 12 western provinces since 1998, yet due to illegal cutting, primary forests in some places have decreased by 6% over this period (Brandt et al., 2012). Ecosystem fragmentation is increasing as a result of rapid infrastructure growth with little coordinated planning (Li et al., 2010). This has been particularly extensive in Xishuangbanna, southern Yunnan, the most species-rich region of the country (Xu et al., 2013). Grasslands, comprising c. 40% of the countries' land area, remain severely degraded, though the pace of degradation has been slowed (Huang et al., 2013). Aquatic systems, including rivers, lakes and wetlands, have been modified extensively and/or polluted by industry and agriculture. Marine pollution has doubled since 2009; Chinas' coastal waters are now polluted over an area of c. 145,000 km^2, stretching from Vietnam to Korea (Zhang and Crooks, 2012). Loss of intertidal habitat is also severe and set to increase; recent studies show that fisheries and ecological services are collapsing with implications for human livelihoods (MacKinnon et al., 2012). Overall, government efforts to protect species and ecosystems have increased, but effectiveness has not kept pace with degradation. For example, the terrestrial nature reserve system has expanded but little progress has been made on major problems (i.e. unmarked boundaries, poor enforcement, low levels of staff training, inadequate funding, rampant commercial development) that were identified 10 years ago (Jim and Xu, 2003; Xu et al., 2012). The central government's large-scale payment for ecosystem services campaigns are remarkable in terms of funding and longevity (Liu et al., 2013a). But program effectiveness remains unclear due to a general lack of science-based assessment (see Ran et al., 2013) and conflicting outcomes with positive results that meet program goals in some locations (Lü et al., 2012; F. Zhang et al., 2013) and mixed (Yang et al., 2013) to poor results (Zhai et al., in press) in others.

3. Food security

China's grain harvests continue to set yearly production records, but food demand is outpacing supply (Fan et al., 2012). To meet demand, the country is importing record amounts of grains; in 2012, China's grain self-sufficiency fell to 87–88% of total production putting pressure on leaders due to the government's traditional commitment to food independence (Li and Sun, 2013; Zhong, 2013). But there are benefits to importing foodstuffs. First, the country can use the 27–33 million h that represents the land needed to grow the soybeans that China imports to produce other high- value crops. Second, China, a water-poor country, gains a measure of "virtual water" by not having to use its own sources to produce imported foods. Nevertheless, as grain imports are projected to increase further in 2013 and beyond according to the China National Grain and Oils Information Center (Zhou, 2013), pressures on the food system are growing. Other factors contributing to China's increasing food insecurity include the world's highest use of fertilizers leading to unmitigated levels of nitrogen deposition (X. Liu et al., 2013), groundwater depletion in key agricultural areas (Cao et al., 2013), extensive soil pollution (Q. Wang, 2013), and a farm work force with an average age of 60 years. Loss of arable land continues due to rapid urbanization; the amount is already likely below the government's "red line" of 121 million h (Li, 2011). These losses are compounded by the fact that many municipal governments rely on income from urbanization-led land sales for much of their revenue.

4. Energy

Energy demand in China continues to grow dramatically and, according to the Ministry of Land and Resources, may not peak until 2030–2035 (Xinhua, 2013a). In response, the central government is ramping up energy production across all sectors. Coal will continue to provide the bulk of thermal power with use projected to increase by 70% from current use over the next two decades (Best and Levina, 2012). In 2012, oil imports rose to 58% of supply; the State Council plans to cap this amount at 61% by 2015 (Du, 2013a), though how to accomplish this is unknown given sales of 14–17 million new passenger vehicles/year. Plans call for a tripling of nuclear power production by 2015, causing China's uranium import dependency to rise dramatically (Froggett, 2012). Hydropower delivered 22% of the countries' energy in 2011; the goal is to increase this amount by c. 66% by 2015 (Information Office of the State Council, 2012). But with no cumulative impacts review of cascades of dams on multiple rivers, it is unclear whether implementation of environmental standards can match the rate and scale of proposed growth (Grumbine et al., 2012; Tullos et al., in press). Non-fossil fuel energy is targeted to contribute 15% of all of China's energy by 2020. However, in 2011, due to institutional implementation and pricing barriers, the State Regulatory Electricity Commission estimates that 23% of wind turbines and 28% of solar panels were not connected to the grid and therefore not contributing to power production (Ma and Zhou, 2013).

5. Water

China faces both water quantity and quality problems. By 2030, demand is projected to exceed supply by 25% (Addams et al., 2009) and conflicts over water are already evident and increasing between agriculture, energy and urban demands. Water usage is highly inefficient in each of these sectors. In agriculture, for example, only c. 45% of irrigation water reaches target crops (S. Peng, 2011), and, in cities, data from the China Urban Construction Statistical Yearbook and a Beijing NGO suggest that pipe leakage rates range from 12% to 23% (Ji, 2011). Water quality concerns are also mounting. Across the country, the Chinese Academy of Sciences reports that 43% of surface water is too polluted to use (Liu and Yang, 2012). A 2013 Ministry of Environmental Protection report

suggests that 57% of urban groundwater, the primary source of drinking water for hundreds of millions of people, is polluted (X. Wang, 2013). Gaps between policy and implementation are wide. For example, there is no urban groundwater quality law and, due to financial and political disincentives, urban sewage treatment is ineffective with c. 66% of plants operating below capacity or not at all according to a report from the National People's Congress (Zheng, 2012). In rural areas, China did not begin to invest in water pollution control until 2008 with the Ministries of Environmental Protection and Agriculture expecting coverage of 10% of all villages by 2015 (Wu and Gao, 2013). However, even if current rates of expansion were doubled, total coverage is still decades away. In 2012 and again in 2013, the State Council and Ministry of Environmental Protection issued new national policies and funding to strengthen water use and decrease pollution (State Council, 2012; Xinhua, 2013b), but institutional reforms necessary for improved implementation have not been addressed.

6. Urbanization

Rural–urban migration and resulting rapid urbanization will power future growth in China. Over the next 17 years, more Chinese than the current population of the US are projected to move into cities (X. Peng, 2011). Decades into the worlds' biggest building boom, 40% of China's buildings have yet to be constructed. Once they arrive, urban Chinese on average consume more water, energy, cars, and material goods than their rural counterparts, though some models show that they attain increased energy use efficiencies compared to rural dwellers (O'Neill et al., 2012). In addition to per capita impacts, as urban areas expand, arable lands are lost and surrounding ecosystem service values (ESV) decline. A representative example would be Hangzhou where, from 1978 to 2008, ESV were reduced by 24.4% (Wu et al., 2013). (Since this study was completed, ESV have likely declined further since Hangzhou has continued to expand with a 2008–2012 population increase of c. 1.5 million people.) To counteract these trends, the central government is supporting retrofits of urban buildings, installing energy use monitors, and dramatically increasing funding for urban energy conservation (Lo and Wang, 2013). But there still are no functional national-level regulations in place to guide the largest and most rapid urban expansion in world history.

The rise of the middle class (by itself a positive development) constitutes another pressure on China's environmental resources. From 2012 to 2020, depending on trend assumptions, these new consumers will more than double to 400 million people (Atsmon et al., 2012). However, for the majority of Chinese who will not join this group by 2020, the governments' social safety net will be paramount. This net is currently in early stages of construction and there are multiple, linked problem areas – health, elder care, income distribution, pensions, and more (Eggleston et al., 2012). One example connecting environmental and social policies with future urbanization is *hukuo* (household registration) reform. Based on data from the National Bureau of Statistics, there are c. 262 million migrant workers living in cities; with their children, these citizens account for about 24% of China's population (Chen et al., 2013). Without an urban *hukuo*, however, they have restricted access to education, housing, and other social benefits. Collectively, this group is so large that if benefits were extended to them in the near-term, many municipalities would go bankrupt (Zheng, 2013a). Yet given the rate and scale of the growth of Chinese cites and resulting impacts on air and water pollution, arable land protection, ecosystem services, and habitat fragmentation, planning and implementation for sustainable urbanization cannot proceed without social reforms.

7. Climate change

Impacts from climate change on Chinas' ecological and social systems are already apparent and projected to gain in strength (National Development and Reform Commission, 2009). International policy debate centers around avoiding a *global average* temperature rise greater than 2 °C by 2100, but the Tibetan Plateau (12.8% of Chinas' land area and a major source of water) will likely reach 3 °C by 2060 (Sanderson et al., 2011). The Asian monsoon is weakening (Bollasina et al., 2011), many glaciers in western China are losing mass and large-scale Tibetan Plateau vegetation shifts are underway (Brandt et al., 2013). Due to inadequate regional climate model simulations as well as poor understanding of specific crop responses to pests, diseases and other factors under a CO^2 – enhanced atmosphere, there is uncertainty about climate impacts on food production in China (Piao et al., 2010). But the key climate policy issue for China is burning coal to satisfy increasing energy demand. The central government plans to slowly reduce the amount of coal consumption, yet to meet national air quality targets and mitigate carbon emissions, China would have to achieve greater and faster reductions and "drastically change" current energy policies (Lim and Gao, 2013). Carbon capture and storage technologies could speed reductions, but there is only one small-scale plant expected to be online by 2020, in contrast with the 363 new coal-fired plants that China currently plans to build (Yang and Cui, 2012). Yet the central government is committed to reducing carbon emissions and recently increased spending on actions to achieve national targets during the 12th Five Year Plan (2011–2015) (Du, 2013b).

8. Directions for policy reforms

After three decades of unconstrained economic growth, China's social–ecological debts are coming due. The new Chinese leadership has a full agenda, yet measured against broad adaptive capacity standards highlighted widely in the literature, the government remains weak at solving complex, cross-cutting problems (Edmonds, 2011; Lee et al., 2012; Sayer et al., 2013; United Nations and Asian Development Bank, 2012; Young, 2011). Experts are in agreement that open information exchange, government transparency, institutional coordination, public and private sector participation, iterative decision making and conflict resolution are critical to resolving environmental and social issues under 21st century conditions. These capacities may have little to do with supporting economic expansion under a command-and -control decision making system, but they are recommended repeatedly to solve governance problems in a world of decreasing resources and increasing uncertainty.

With the above criteria in mind, to strengthen the government's adaptive capacity across the sectors discussed in this paper, we suggest that China's new leaders consider a raft of specific policy reforms. Out of the host of actions that could be recommended, we believe that the following would likely have the largest near-term impacts.

To reduce ecosystem degradation, the state must replace quantity-oriented environmental campaign targets with those emphasizing ecosystem functioning. Monitoring must become an integral part of program evaluation; this will require that current payment for ecosystem services plans be revised and accelerated (see Yi et al., 2013). China has few programs to protect biodiversity through landscape connectivity (Zhang et al., 2012); the international scientific work that has been accomplished in this area should serve as a model for policy reform. To bring ecosystem protection into general policy planning across the water, food, and energy nexus, there are programs from other countries that the state

can adapt to conditions in China (National Fish, Wildlife and Plants Climate Adaptation Partnership, 2012). After 10 years, China's environmental impact assessment law remains a work in progress. From 2006 to 2010, an average of only c. 200/year administrative court cases were heard under the law (Economy, 2013); this rate can only be increased through stronger rule of law-based implementation. In addition, cumulative effects analysis should be added to a revised EIA statute and payments by developers for assessments ended (Wu and Jiang, 2013).

The government is already addressing food security through technical solutions including introducing high productivity, drought-resistant crop varieties and ecosystem model-based soil-cropping management (K. Zhang et al., 2013). But more programs supporting improved yields combined with overall agricultural resources efficiency need to be implemented (Shen et al., 2013). With 47.6% of municipalities' current revenue dependent on land sales according to recent government reports, changing tax distribution ratios between the central and local governments and introducing new funding mechanisms (i.e. municipal bonds) to increase fiscal support to local governments are requirements for strengthening protection of arable land (Zheng, 2013a). Food policy has yet to be coordinated with water and energy production; this must change.

In China, energy policy reform is not just about increasing supply; it is also about market pricing, reducing subsidies for high carbon content fuels and linking energy supply with coordinated urban planning. These actions can be accompanied by (1) setting and enforcing new energy efficiency promotion incentives for officials at all levels of government; (2) strengthening implementation of already-existing urban building codes; and (3) improving cross-sectoral planning for the cities of the future. There are a host of energy efficient building scenarios for the government to draw upon; the issues are providing funding to local governments and, more important, having the institutional capacity to scale up actions to meet the pace of growth. At the international level, China, the world's largest consumer of energy and biggest emitter of greenhouse gases, would benefit from joining the International Energy Agency. More internationally-coordinated carbon capture and storage research to reduce China's coal burning emissions footprint is also critical.

There are as yet few policy links between energy, water and overall development planning. In fact, recent scholarship suggests that China faces a "paradigm shift" in water policy from a primary focus on engineering solutions to one where coordination between institutions, monitoring, and cooperation take precedence (Liu et al., 2013b). This can be accomplished through reform of current water laws (including the creation of China's first groundwater quality statute) and forging of legal water management mandates between provinces and water bureaus within river basins, while encouraging more policy participation from citizens, NGOs and businesses (Moore, 2013). Some of these reforms go against current government norms, but international scholars believe that water scarcity will drive more cooperative institutional behavior (Subramanian et al., 2012).

Environmental policy reform would be well-served if the government unhitched its conception of social development from economic growth. In general, this means greater support for social reforms: More equitable distribution of wealth and social benefits; stronger rule of law; and greater public information disclosure and civil society participation. The government could then use this expanded social–ecological frame to better manage the most pressing issue: rapid urbanization. The 300–400 million people moving to cities over the next decades will impact ecosystems, agriculture, water, human health and energy production in complex ways, yet this movement will provide opportunities to strengthen social-ecological linkages between urban and rural China (Ding, 2013). Specifically, the government must direct a fundamental redesign of urban planning focusing on city clusters, integrated transport, *hukuo* reform and green building construction while also building a more equitable balance between urban and rural economies. (Lo and Wang, 2013). At the same time, institutional capacity adjustments are required to refine how the government allocates funding for new urban and rural services. Economists from several government research institutes are concerned that these reforms are already proving difficult to implement in the current political system (Yao, 2013). Nevertheless, improved governance across a dynamic rural- to- urban continuum can be a positive form of social capital providing a hedge against uncertainties surrounding China's mammoth urban transformation.

Climate change also challenges the state to act in a more adaptive manner. With sea-level rise projected to negatively impact trade and migration in China, and in light of the low level of local officials' knowledge, one area to experiment with adaptive capacity and institutional coordination would be central government-led mitigation pilot projects in coastal zones (Jin and Hermi, 2013). Experts from the International Low-carbon Economy Institute in Beijing suggest that more finely-crafted carbon intensity targets that reflect regional differences across China would also spur more efficient emissions reductions (Zheng, 2013b). And, despite complex international politics, given projected negative climate impacts on China, the government should increase its efforts toward adoption of international global emission standards (Hart, 2012).

9. Environmental policies and institutional reform

The majority of policy analysts recognize that China over the last decade has made great strides in addressing environmental problems. Many experts also believe that the state now faces new challenges where status quo institutional approaches are less certain to yield future benefits. These old approaches include: top-down decision making and management; lack of monitoring and assessment of projects; inadequate coordination between government bureaus; insufficient consideration of local interests; and poor use of best technical practices (see Yin and Yin, 2010; Xia and Pahl-Wostl, 2012). The amounts of funding that the central government has committed to spending on environmental issues over the next decade are impressive – for example, four trillion renminbi (c. 6.35 billion USD) for water (Liu and Yang, 2012), 1.7 trillion renminbi (c. 2.83 billion USD) for air (Xinhua, 2013b) and 50 trillion renminbi (c. 8 trillion USD) for urban development (Bloomberg, 2013). (The latter figure is equivalent to the size of China's economy in 2012.) But as one can surmise from the issues described in this paper, money will only provide a limited amount of leverage over problems that are institutional in nature, and so institutional reform and renewed capacity building will be key. Several critical questions frame the tasks that the government must address: Will greater funding for environmental problems stimulate cross-government coordination? Will new policies facilitate sustainable rural–urban flows of capital, technology and resources? Will implementation be sufficient given gaps between central government policy and local government action? Will the pace of institutional change match the growth of problems that reforms seek to address?

Since taking office, China's new leaders have wasted no time in initiating reforms in every sector highlighted in this review. Recently, President Xi spoke of a new system of "functional zoning" to control ecosystem degradation and a general system of environmental protection based on the "most stringent" application of rule of law (Wu, 2013). While laudable, these statements point toward

the profound institutional capacity and governance problems that China now confronts. If a rules-based system must become part of the answer for China's environmental problems, is the government now prepared to address matters of constitutional rights that form the fundamental basis for the country's rule of law but have never been implemented since passage in 1982 (Ford, 2013)? If not, would a "rule of law with Chinese characteristics" that was *not* linked to constitutional rights be effective as an agent of environmental policy reform? What would such a system look like? Deeper still, are international standards of adaptive governance to solve environmental issues under conditions of uncertainty limited to relatively open, rule of law-based systems and therefore reflect biases against other forms of governance? More specifically, is adaptive problem-solving advice universal or is China somehow an exception? If so, how?

China has already proven that it can build a powerhouse economy and pull hundreds of millions of people out of poverty. Now it is time to construct an adaptive state under 21st century conditions of dwindling resources, increasing costs and climate uncertainty. The tasks are daunting: China must restructure its economy to a degree not seen since the 1980s, revamp environmental policies to reverse decades of ecosystem deterioration, and renew its social contract to citizens as they face unprecedented urbanization. And reforms must be implemented better than current policies. It is clear that the government's status quo choices – massive environmental campaigns bereft of monitoring and top-down technological solutions lacking coordination in and across the state bureaucracy – will not be sufficient to address the inadequacies of current policies or spur institutional reform. A reframing of state stability to place environmental and social concerns on par with economic growth offers the best hope for China to meet current and future resource demands.

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