

A nexus approach for sustainable development in Ningxia, China

China has been a global leader in setting innovative environment and development targets. Of 17 mandatory targets in China's latest five-year plan, 12 address the natural resource base. Other examples include the "Grain for Green" or Sloping Lands Conversion Programme and, more recently, China's "Red Lines" (sustainable-use targets) for water, land and energy/carbon.

Given the importance of both development and environmental protection for China's future, the question arises: Are these laws and the underlying targets consistent and mutually reinforcing, or are they generating unintended negative externalities and new trade-offs across sectors and resources? The same applies to national vs. province-level policies: Are the provincial targets consistent with one another and with national goals, and do they support the sustainable development of China as a whole?

The water-energy-food nexus framework, which is being used worldwide to examine interactions across sectors and between human and environmental systems, provides a useful lens



through which to examine these questions. This discussion brief describes ongoing work by SEI to apply an analytical nexus framework in Ningxia,¹ an arid, rapidly developing province in northern China that extends across the Loess Plateau and the Yellow River plains.

Per-capita GDP has grown at almost 20% per year, and population at more than 1% per year over the past five years.² We have begun to analyse Ningxia's water, land, and energy resources and their interdependencies.

Growing water demand amid scarcity

While Ningxia has access to water from the Yellow River, its per-capita water availability of 659 m³ per year is very low relative to China's average – 2,100 m³ – and the global average – 7,500 m³ – (Ningxia Department of Water Resources, 2011). Yet Ningxia also needs a great deal more water: more than a third of the rural population – about 1.5 million people – lack access to safe water, and the province needs to greatly increase food production. A 2011 survey found the daily caloric intake of students in the Ningxia region was only 62% of the recommended level (Cheng 2011). Agriculture in the province is heavily dependent on irrigation, and the irrigated area is projected to increase by almost 250,000 ha between 2010 and 2015 (Government of Ningxia Hu Autonomous Region 2013a).

Under China's Red Lines for water, Ningxia may withdraw 7.3 billion m³ of water in 2015, and 8.8 billion m³ in 2030 (State



The Ningxia landscape: a mix of desert, arid agricultural land and urban and industrial space.

Council 2013). It is not clear whether this allowance accounts for environmental flow requirements – the water demands of aquatic ecosystems. Currently 91% of Ningxia's water, 6.7 billion m³, comes from the Yellow River, which has its resources fully committed (Ningxia Department of Water Resources 2011). Thus, any increase in Ningxia's withdrawals would come at the expense of downstream river sections and provinces. Expanding Ningxia's water supply also has energy implications, primarily for water pumping and treatment.

Rapid changes in land use

China's Grain for Green program has transformed large tracts of Ningxia's agricultural land – particularly sloping and low-productivity land – into forest. From 1995 to 2012, forest cover in Ningxia more than tripled, from 4.2% to 12.8%. At the same time, China's and Ningxia's Red Lines on land require maintaining or slightly increasing the area under cultivation (Government of Ningxia Hu Autonomous Region 2013b). The area covered by cities, industry, mining and transportation infrastructure, in turn, grew by 2.3% per year in 2000–2012. In the same period, Ningxia's grassland area shrank by about 8%, from 2.44 million to 2.25 million ha.

Grassland is projected to keep decreasing due to land demand as well as soil erosion. So-called "unused land" is to be put into productive use, or be used more intensively. While this can increase overall land productivity, helping to meet growth targets, it is important to also protect the biodiversity and resilience of these areas, as well as the ecosystem services they provide, such as carbon sequestration. In addition, the water scarcity implications of afforestation must be considered, as the trees being planted have higher water demand than other types of vegetation.

Rising energy demand, met with coal

Ningxia holds 3.4% of China's coal resources and has enormous solar and wind power potential, but it also has rapidly rising energy demand, and many of its rural households have little or no access to electricity. From 2004 to 2011, primary energy production in Ningxia more than tripled, and according to China's downscaled energy targets, energy production in Ningxia is to increase by more than 12% annually between 2010 and 2015. The annual growth target for non-fossil-fuelled energy produc-

¹ Officially, the Ningxia Hui Autonomous Region.

² Unless otherwise noted, data on Ningxia are taken from annual yearbooks by the Statistical Bureau of Ningxia Hui Autonomous Region.

tion 33%; for wind, 45%, and for solar, 61% (Government of Ningxia Hu Autonomous Region 2012). Still, coal is expected to account for 95% of primary energy production in 2015.

For example, Ningdong Energy and Chemical Base,³ a large-scale regional industrial zone close to the Yellow River, is built around coal. It is slated to be one of China's key coal producers, with an annual output of more than 100 million tonnes – and this, in turn, will increase water demand by at least 0.4 billion m³ by 2015 (Greenpeace East Asia 2012). Conflicts with sustainable water management are to be expected, especially if power plants continue to rely on wet cooling technologies, which may also harm aquatic ecosystems by discharging hot water into them.

The increase in coal use may also conflict with China's overall coal cap, 4 billion tonnes of standard coal by 2015, as well as greenhouse gas emission targets. Ningxia is projected to decrease per GDP unit carbon intensity by about 16% and NOx emissions by about 9% between 2010 and 2015. China is now discussing coal liquidification or gasification to mitigate air pollution, but this would further increase both energy demand and GHG emissions.

A nexus perspective on Ningxia

Our initial analysis reveals several potential conflicts or trade-offs between Ningxia's water, land and energy targets, particularly given the province's water and, to a lesser extent, land constraints. Increasing resource use efficiency, which is generally low in Ningxia, could help; for example, the province's energy consumption per unit of GDP or per unit of industrial value added is among the highest in China.

The government is starting to address this issue, with targets to increase energy efficiency by 15% and water use efficiency by 27% between 2010 and 2015 (State Council 2013), but more can be done. The targets for compliance with water quality standards could also increase the usability of water and hence the efficiency of its use. Similarly, land use efficiency could be greatly increased by reducing or reversing land degradation; a target has already been set for comprehensive soil erosion control on another 5,000 km², or almost half of Ningxia's total cultivated land. Land use efficiency improvements often increase agricultural water use efficiency as well.

There is a need for better coordination across Ningxia's resources, sectors and targets, to align policies and goals and Red Lines for water, land and energy. Sustainability also needs to be addressed more consistently. Through its agricultural and energy production, Ningxia is a net exporter of "virtual water and land" to other regions. While other parts of China are benefiting from unsustainable resource use in Ningxia, a national green economy can only be achieved by improved configuration of production across all provinces, maximizing overall resource use efficiency.

A nexus approach can support this process by systematically assessing the externalities of each target and potential synergies among targets and from that identifying ways to meet sustainable development goals. SEI's work in Ningxia continues, with

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Watermelon farmers in Ningxia, where agriculture is strongly dependent on irrigation.

participatory scenario analysis using SEI's nexus toolkit, which includes the Water Evaluation and Planning (WEAP) system and the Long-range Energy Alternatives Planning (LEAP) system.

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