

Climate Change
March 2014

No water, no food

Ensuring food safety and food security in China

China's agricultural output is as large as Australia's entire economy and almost 30% of it comes from the water-scarce and polluted North China Plain

As a result, the government is tightening regulations on water usage, as well as water and soil pollution

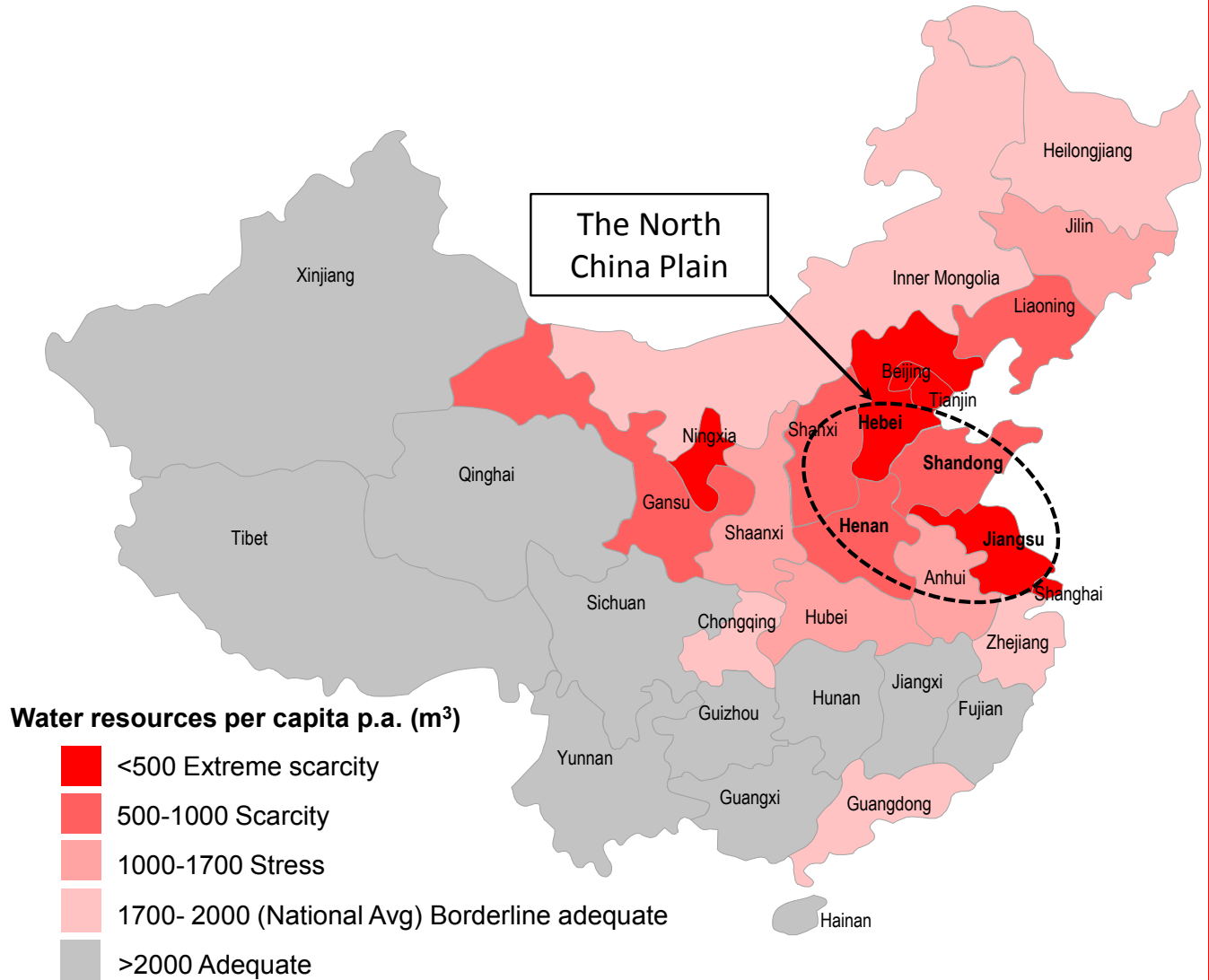
The country's increasing focus on food safety and security could lead to higher food imports

HSBC Climate Change Centre commissioned China Water Risk to research and analyse the findings which form the basis of this report

By Wai-Shin Chan and Zoe Knight

Disclosures and Disclaimer This report must be read with the disclosures and analyst certifications in the Disclosure appendix, and with the Disclaimer, which forms part of it

China's annual water resources per capita



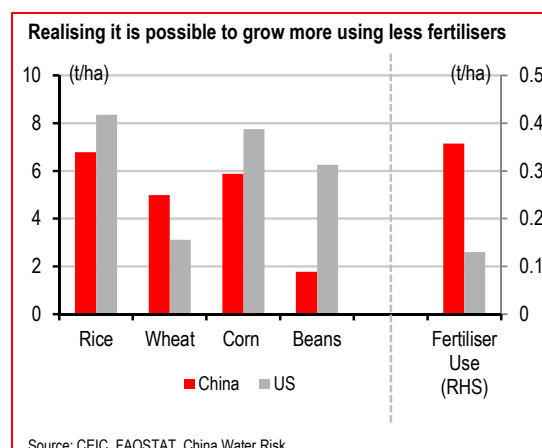
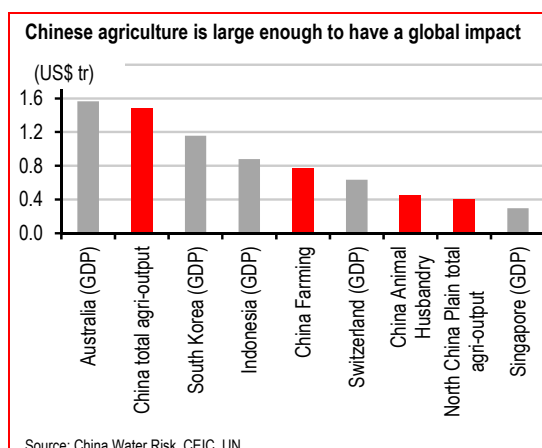
Source: China Water Risk (based on China Statistical Year Book, historical average water resources by province 2003-12)

Summary

- ▶ Over a quarter of China's total agricultural output comes from the North China Plain – but this region is water scarce and polluted
- ▶ Incoming pollution control regulations could slow the 'more fertiliser, more yield' model, as the food supply-demand dynamics change
- ▶ Food safety and security are priorities but to ensure them China may have to import more food – which would affect global trade

China's total agricultural output is USD1.5trn: This figure is similar to the entire Australian economy. China's farming industry (grains, fruits and vegetables) is almost the size of Indonesia's economy and the output of its one billion livestock animals (pigs, sheep, cattle, etc.) is worth more than 1.5x the Singaporean economy. The North China Plain (Hebei, Henan, Shandong and Jiangsu) is a key agricultural region, accounting for 28% of China's total agricultural output. This region grows one-tenth of *global* wheat production (or more than the entire wheat production of the United States) and commands one-quarter of China's pig production (again more than the entire pork supply of the United States).

Land, water and soil are essential for agriculture: Appropriate arable land, good quality soil and a steady supply of water are required to grow crops. However, only 14% of China's total land area is currently used as arable land; the country as a whole is close to water-stress levels, and soil has become polluted through the overuse of fertilisers and heavy metals from industry. The North China Plain is water-scarce and highly reliant on depleting sources of groundwater of which 70% is so polluted that it is not fit for human touch, according to a Ministry of Land and Resources survey. At the same time, this region accounts for 31% of fertiliser use, which compounds the water resources problem.

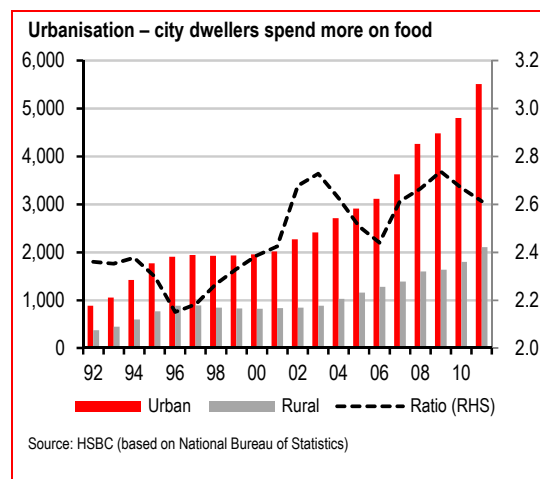
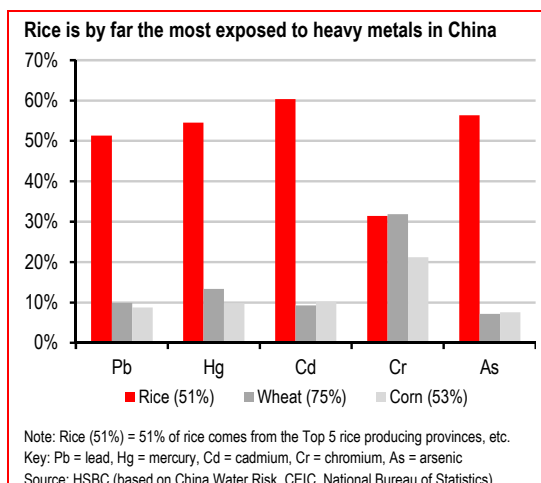


The government is addressing the water and pollution problem: Ensuring the availability of water, its efficient use and its quality is becoming increasingly apparent in agricultural policies. Water is an integral consideration of agricultural policies because of the mismatch between the location of sown lands and water resources. This is not easy to address since agriculture is the top user of water in China, accounting for 63% of national consumption but also accounting for half of China's water pollution through fertiliser runoff and livestock waste. China does not yet have the infrastructure in place to deal with all this waste, but it is setting tougher targets on pollution control. We think tougher pollution control will mean that yields can no longer be driven mainly by fertiliser use, but farming will have to shift to a better fertiliser mix and agricultural technology. The Chinese government realises that it is possible to grow more using less fertilisers.

Food safety and food security worry the nation: Three-fifths of China's sown area is exposed to 85% of the nation's heavy metal discharge – with rice the most exposed grain and Hunan the most exposed province. At the same time, food demand is increasing in China, driven by rising affluence and urbanisation. Not only do city dwellers spend more on food, but Chinese diets as a whole have been trending towards more meat consumption. Ensuring food self-sufficiency requires the collaboration of various ministries (agriculture, land, water and energy) to tackle water shortages, to change the Chinese diet, to consolidate farmland, to optimise grain yields and to prepare for the effects of **climate change**.

Changing global trade patterns: What happens in China could completely change historical patterns of the global food trade. We think China will save domestic grain production for human consumption while importing grains for animal consumption, as it has done with soybeans. Any potential crop failures and yield erosion from climate change-related events could also lead to more imports. Changes in China's consumption mix (more meat), pursuing basic self-sufficiency, as well as the need to protect water resources and pollution control could also cause more imports.

Key trade themes: The HSBC report [Global agricultural commodities](#), March 2014, contains ideas to capitalise on some of the themes discussed in this report. In summary, as middle class incomes rise, demand for dairy products is expected to increase, supporting Chinese dairy producers and countries like New Zealand. Demand for meat from Latin America, Australia and New Zealand is also set to rise. Brazil is expected to get support from sugar exports; Asian palm oil is set to see high demand.



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HSBC's Climate Change Centre commissioned China Water Risk (CWR) to research and analyse the findings, which form the basis of this report. Based in Hong Kong, CWR is a non-profit initiative dedicated to addressing business and environmental risks arising from the country's urgent water crisis. It aims to foster efficient and responsible use of China's water resources by engaging the global investment and business communities, civil society and individuals in understanding and managing China's water risk.



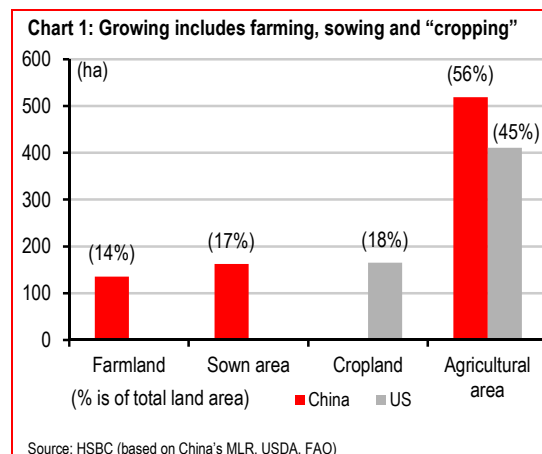
Agriculture and water – a tough balancing act

- ▶ Water is essential for agricultural, but there is a mismatch between the location of arable land and water resources in China
- ▶ Agriculture is the largest single user of water, yet also accounts for half of China's water pollution through excessive fertiliser use
- ▶ Therefore, ensuring the availability of water, its efficient use and its quality is becoming increasingly apparent in agricultural policies

Growing requires land and water

Growing area depends on definition

Officially, there is only 135m hectares (ha) of arable land in China¹, representing a mere 14% of the total land area. However, China's "total sown area for farm crops" – defined as the area of land sown or transplanted with crops regardless of being in cultivated or non-cultivated areas – is much larger, at 163m ha. This is similar to the 165m ha of "croplands" in the United States. The total agricultural area in China is much larger, according to the FAO², at 519m ha (Chart 1).



Agriculture universally requires water

Agriculture is a large user of water, accounting for 70% of total freshwater withdrawals globally. In China, agriculture's share of water use has fallen slightly over the past decade but remains the largest consumer of water, at 63%. This proportion is relatively high compared to the US but is similar to Brazil (Chart 2).

¹ According to the 2nd National Land Use Survey, Ministry of Land & Resources, and the National Bureau of Statistics, December 2013

² The Food and Agriculture Organization of the United Nations

Map 1: China's 2012 sown area mapped onto water resources

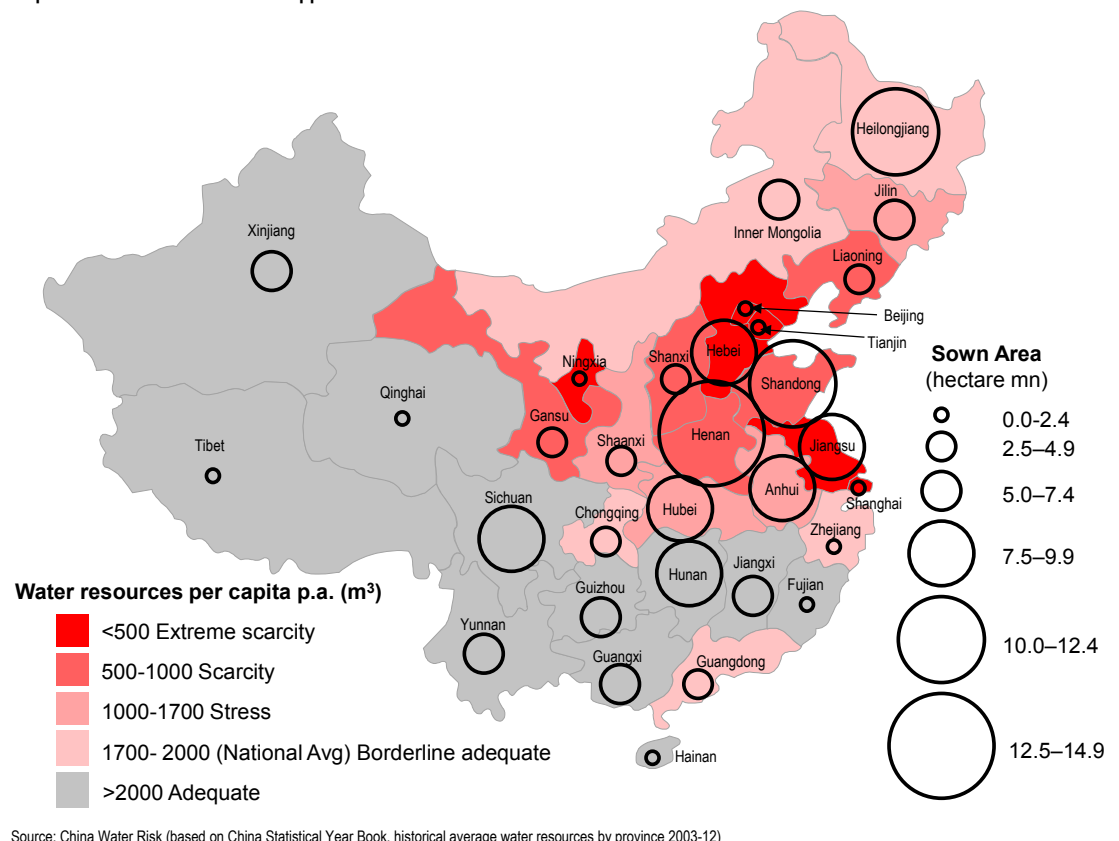
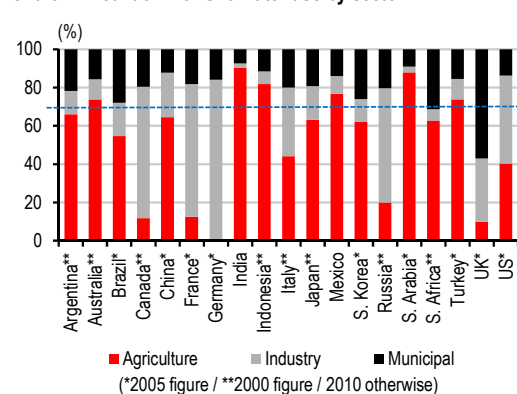


Chart 2: Breakdown of G20 water use by sector



Source: FAO Aquastat

Arable land and water are mismatched

It is clear that managing water in agriculture is key to water resources management in China. The mismatch between the location of arable land in China and water resources adds to the complexity of managing both agriculture (food security) and water resources (given limited availability).

Most of China's large farming provinces lie in the North China Plain (Henan, Hebei, Shandong, Jiangsu provinces, and parts of Anhui). The mismatch can be seen in Map 1, which shows that 34% of total sown area is located in water-scarce provinces.

Water is a key element of agricultural policies

Various policies have been set at both the national and the provincial level to ensure the water supply-demand gap can be met and, given water is key to agriculture, these water policies have implications for agriculture. China's framework for water conservancy affects agriculture in three main ways: water use, efficiency and pollution control.

- Water use:** water allocation to agriculture will likely fall to meet national water quotas (despite the rise in demand for agricultural products);

- 2 **Water efficiency:** irrigation will likely be expanded and improved, diets will likely be optimised to be less water intensive with yields to be improved through agricultural technology; and
- 3 **Water pollution:** pollution control policies will likely be implemented to meet new limits (especially fertilisers from agriculture and heavy metals from industry).

The government's desire to achieve an optimal balance of the water-energy-food nexus requires many reforms, including changes to relevant laws and investments in water conservation. In 2014, the government plans to allocate RMB70bn (USD11.4bn) to protect and divert water sources, as well as develop efficient irrigation.

Water use – national water quotas

In 2011, the government imposed stepped national water use quotas of 635bn m³ (by 2015), 670bn m³ (2020) and 700bn m³ (2030). Total water use at the end of 2012 was 614bn m³.

In [Quality before quantity](#), 4 July 2012, we projected water use by sector through to 2030, based on the water intensity of industry. We estimated that the increase in withdrawal by industry should be largely met by a decrease of withdrawals from agriculture, assuming that water savings in agriculture started immediately.

Recent data show that this has not happened and that water use by agriculture actually increased from 2010 to 2012, whilst industrial and municipal use fell. This goes against the planning quotas in the Ministry of Agriculture's (MOA) 2012 opinions,³ which signalled no increase in agricultural water use to 2025. The MOA opinions also imply that agriculture requires 390bn m³ of water resources, similar to the 388bn m³ used in

2012 – this is 30bn m³ more than the central government's allocation of 360bn m³ by 2025.

Water efficiency – more crop per drop

The 360bn m³ target set by the central government requires an increase in the area of irrigated land, as well as an improvement in the efficiency of irrigation.

Definitions

Irrigated land: refers to an area of land that is effectively irrigated, i.e. relatively level land, where there are water sources or complete sets of irrigation facilities to lift and move adequate water for irrigation purpose under normal conditions.

Efficiency of irrigation: measures the effectiveness of the water used on irrigated land. It is measured using an irrigation efficiency coefficient (IEC) – the ratio of net water used by crops to total water use in the irrigation system.

Although irrigation in China has improved over the last 30 years (Chart 3), the area of un-irrigated sown land has been constant at around 100m ha since 1980. This is despite the 3x faster growth of irrigated land area against total sown land (in CAGR terms).

³ Opinions on promoting water-efficient agriculture development, MOA, January 2012

Map 2: Much of China's sown land in key agricultural provinces is not yet irrigated

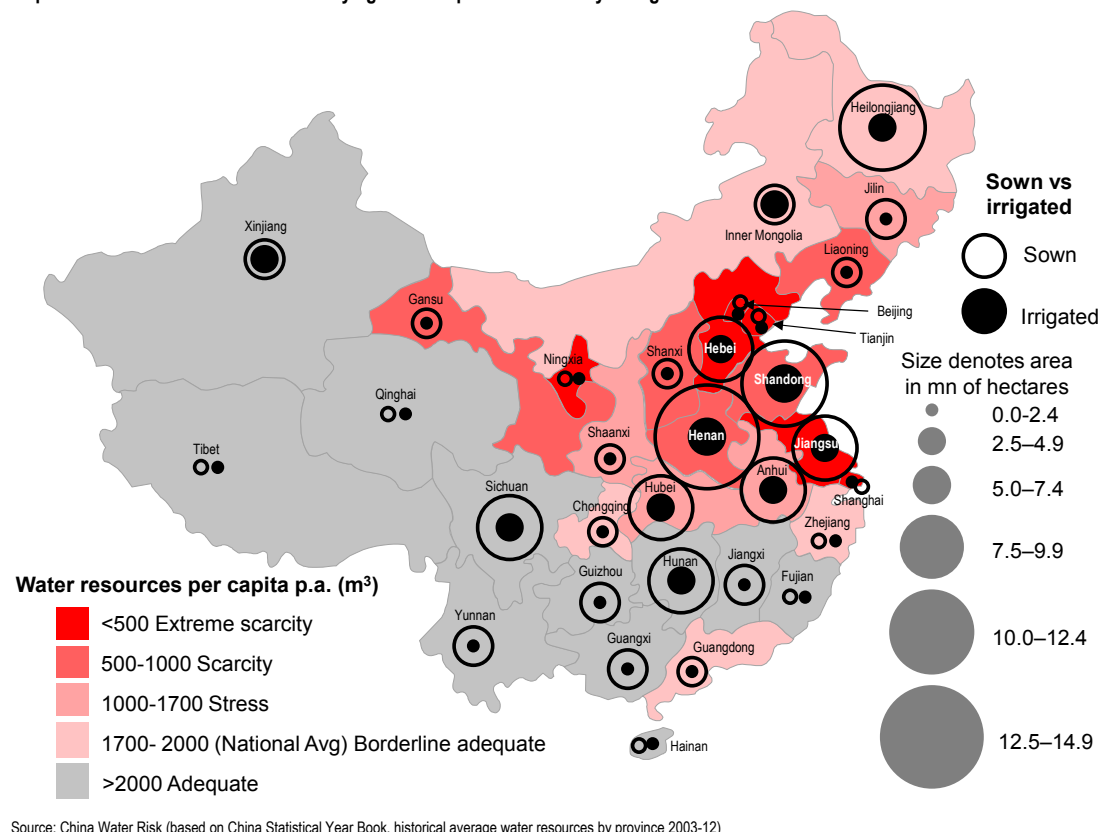
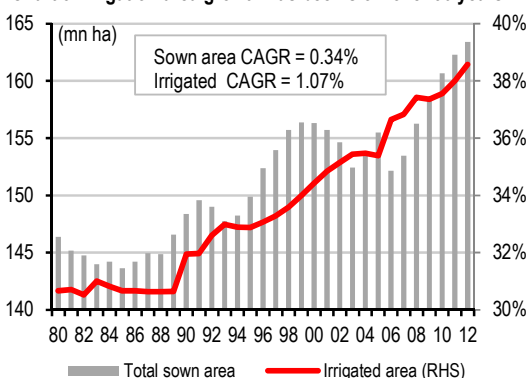


Chart 3: Irrigation area growth has been slow over 30 years



Note: CAGR = compound annual growth rate
Source: HSBC (based on China Water Risk, CEIC)

The picture is similar when we analyse where the irrigation is most needed. Currently, only 38% of irrigated land lies in water-scarce provinces (Map 2). Again, the farming provinces in the North China Plain require significant improvements in irrigation.

Irrigated land area “reflects drought-resistance capacity of the cultivated land in China”, but it does not mean that the water is used efficiently – irrigation efficiency coefficients (IEC) measure this aspect. In 2012, the State Council set targets for IEC of 0.53 (by 2015), 0.55 (by 2020) and 0.60 (by 2030). Most of the provinces in the water-scarce North China Plain have been given an IEC target 5-21% above the national targets.

In addition, water tariff reform is unlikely to affect agricultural water efficiency since farmers currently do not pay for water use.

Water pollution – more means less

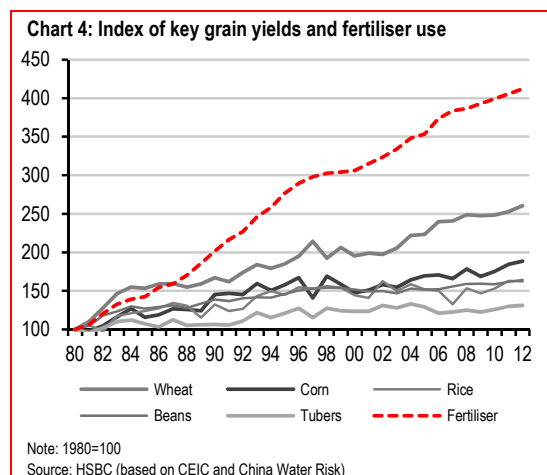
Water availability depends both on its quantity and its quality, as polluted water is effectively useless for most purposes. Since China suffers from both limited arable land and limited water, the government has recognised the importance of

protecting arable lands from excessive water pollution (from any source – fertilisers, pesticides, heavy metals, etc.).

Agriculture (fertilisers) a major water polluter

National surveys⁴ show that agriculture accounts for around half of China's water pollution. The rapid growth (and inefficient) use of fertilisers and pesticides is one of the main culprits.

(The government currently does not disclose data on pesticide use, but it is in the process of drawing up new policies to address excessive and toxic pesticide use. At this stage, we focus our discussion on fertilisers.) Fertiliser use has significantly improved grain yields since the 1980s: wheat yields have improved 2.6x, and yields of corn, rice and beans more than 1.5x; however, fertiliser use per hectare has increased well over 3x (Chart 4).



The improper application of the fertiliser mix (N, P and K)⁵ has contributed to high pollution levels. As such, the government is advancing soil testing (to test for the optimal fertiliser mix for soil types) and establishing standards for compound fertiliser production – with a view to increase compound fertilisers to be 40% of the fertiliser mix by 2015.

(For more on fertilisers, see page 52 of [Global agricultural commodities](#), March 2014.)

Although the government has pushed to modernise agriculture for over a decade, this “bad fertiliser habit” has continued. This is because the small plot sizes of Chinese farms make monitoring difficult and the education of individual farmers (in appropriate fertiliser use) is a complicated task. However, we expect this aggressive fertiliser-yield model to change because of provincial pollution reduction targets, and lower marginal gains in yields. In addition to protecting water resources, reducing water pollution can help to protect soil quality and, very importantly, alleviate food safety fears.

Water pollution also affects the safety of drinking water. Indeed, a key target of the government is to provide safe drinking water to all rural residents by 2015, but we do not discuss this in detail in this report.

⁴ Joint survey by the Ministries of Land & Resources, of Agriculture, and of Environmental Protection

⁵ N = nitrogen, P = phosphorus in the form of phosphates, K = potassium in the form of potash

Food safety worries the Chinese people

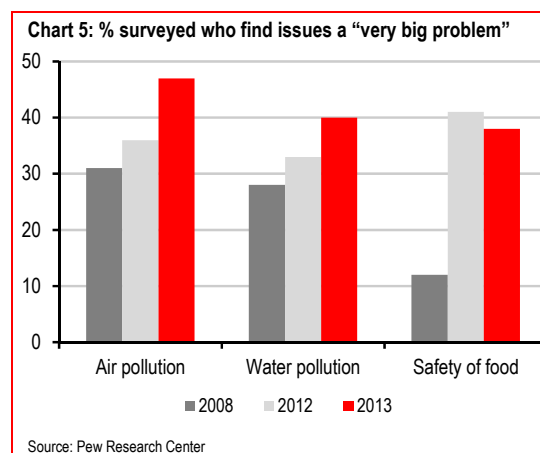
- ▶ Water pollution can translate into soil pollution, which restricts the amount of arable land and takes many years to clean up
- ▶ Regulation of pollution for agriculture affect both crops (fertiliser use) and animal husbandry (waste from China's 1bn animals)
- ▶ Three-fifths of sown area is exposed to 85% of China's heavy metal discharge – rice and Hunan are most exposed

Pollution, people, politics

Public debate over air pollution since 2013 has spurred the new leadership into getting serious about cleaning up (see [China's year of the environment: Pollution prevention first, clean up later](#), 17 December 2013). A survey by the Pew Research Center found that after inflation, corruption and inequality, pollution (air and water) and food safety are the next top concerns; many Chinese view water pollution and food safety as a "very big problem" (Chart 5).

China's own surveys⁶ paint an even bleaker picture. The Ministry of Environmental Protection (MEP) found that that 80.9% of those surveyed expressed "deep concerns" about the overall environmental conditions of China, with 86.8% "highly concerned" over drinking water and food. Indeed, a Chinese news agency's survey ahead of

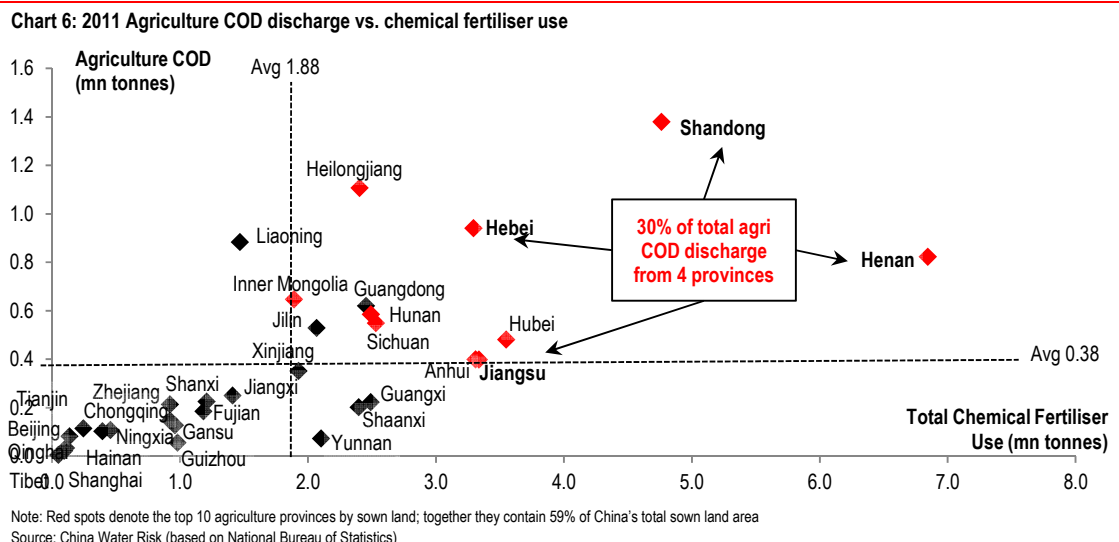
the recent NPC and CPPCC⁷ meetings asked readers to choose one issue they were concerned about at the meetings – food safety came in third.



The government has recognised that food safety is one of the top concerns of the people. In his 'Report on the work of the government' at this year's NPC meeting, Premier Li Keqiang stated "We will... apply the strictest possible oversight,

⁶ National Ecological Civilization Awareness Survey, published by the MEP, February 2014

⁷ National People's Congress, National Committee of the Chinese People's Political Consultative Conference



punishment and accountability to prevent and control food contamination and ensure that every bite of food we eat is safe.”

Food safety and pollution

Water pollution from agriculture and industry has resulted in soil pollution – in turn, this further restricts China’s already limited arable land. For example, Wang Shi Yuan, Vice Minister at the Ministry of Land and Resources (MLR), recently lamented that 3.33m hectares are too polluted to grow crops and have been withdrawn from agriculture.

The government has noted the concerns over food safety and in particular over cadmium and chromium in rice. The response to protect arable land from pollution will likely have implications for the agriculture sector (e.g. fertilisers, pesticides and dead animals), as well as water-intensive and polluting industries (e.g. heavy metals).

Agricultural pollution – COD and NH₄

Almost half of China’s COD (chemical oxygen demand, a key measure of water pollution), and one-third of NH₄ (ammonium) discharge come from agriculture. This discharge is mostly related to fertiliser use (Chart 6). The four main provinces in the North China Plain alone account for 30% of

total agricultural COD discharge and 28% of agricultural NH₄ discharge. These and other water-scarce provinces also have stricter COD and NH₄ reduction targets, according to the 12th Five-Year Plan (12FYP).

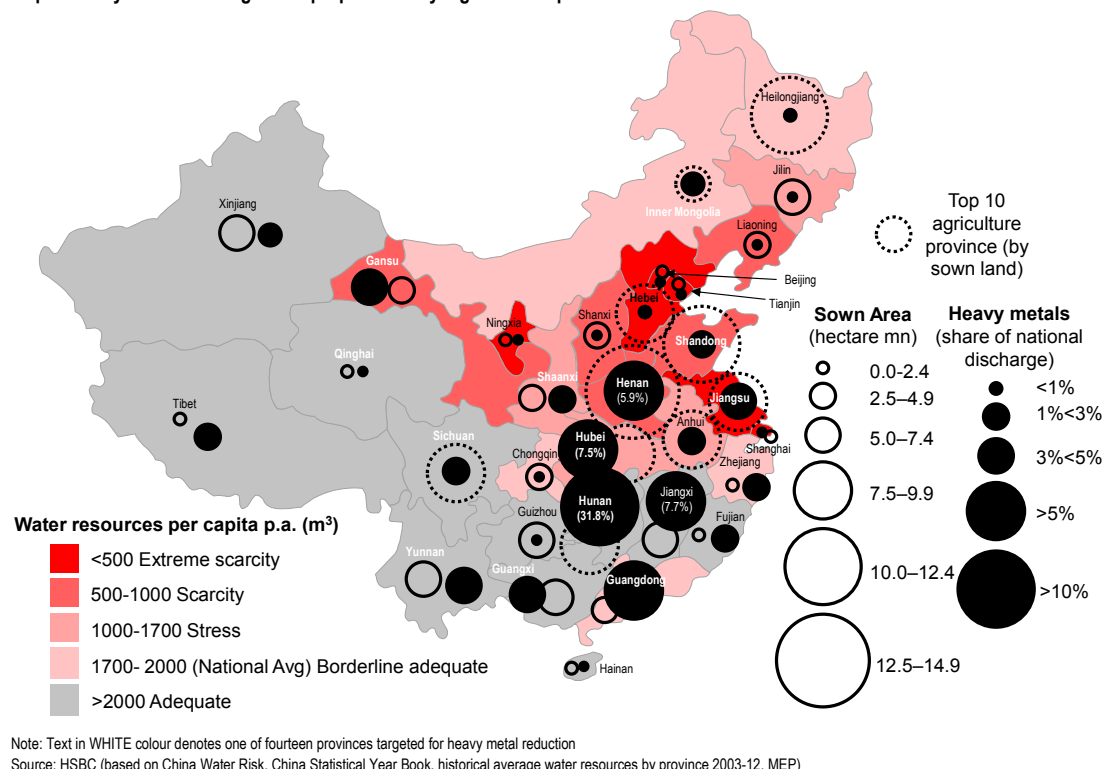
Based on the analysis by China Water Risk, we find that wheat and corn are most exposed to agricultural COD and NH₄ discharge from inappropriate fertiliser use. For example, 75% of China’s wheat and 53% of corn is grown in provinces that produce over half of agricultural COD and two-fifths of agricultural NH₄.

The balance between fertiliser use, pollution and yields is difficult to get right. Various fertiliser policies indicate modest growth in fertiliser demand, but there is a trend towards mediating this with appropriate application (soil testing, optimised mix, specific formulae, etc.).

Pollution from livestock

China has over one billion livestock animals (pigs, sheep, cattle, etc.), but the infrastructure to deal with all the waste produced from these has not kept up with China’s growing appetite for meat. For example, a one hectare pig farm can produce over 20,000 pigs *per year*; these pigs produce over

Map 3: Heavy metal discharge is disproportionately high in some provinces



100 tonnes of waste *per day* (according to the Feixi County Zhengjia Boar Company).

The thousands of dead pigs and ducks floating down the river in 2013 highlighted some of these infrastructure issues affecting agriculture and animal husbandry in China. The carcasses only increased the public's concerns over water pollution and food safety. Following the public outcry over the dead pigs in the Huangpu River, the State Council issued new regulations⁸ tackling pollution from agriculture, in particular from livestock.

We have previously written on the theme of tougher enforcement of stricter environmental laws in China. The penalties for pollution from livestock have been increased, environmental impact assessments are becoming mandatory,

with even greater penalties if drinking water is affected. It is important to note that the fines are sizeable for individual farmers (with small plots). We think this highlights the government's desire to consolidate farms or increase the size of farms, as indicated through various policies⁹ that discuss this scaling-up issue.

Heavy metals in food

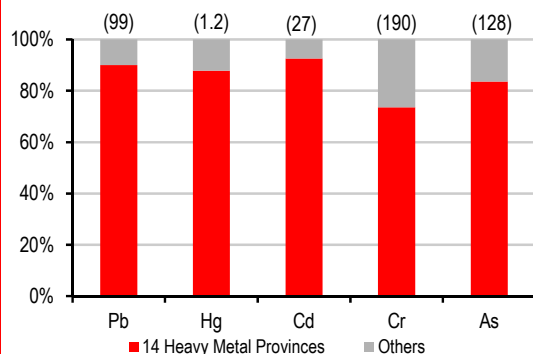
In February 2013, the MEP officially mentioned 'cancer villages' (癌症村) and linked it to heavy metal discharge from industry. The MEP had previously identified¹⁰ 14 provinces where heavy metal pollution would be targeted (Map 3). These provinces contain 98m ha, or 60% of China's total sown land area; moreover, they account for the lion's share, or over 85% of the country's heavy metal discharge (Chart 7).

⁸ Prevention and Control of Pollution from Large-Scale Breeding of Livestock & Poultry, State Council, 11 November 2013

⁹ The Modern Agriculture Development Plan (2011-15)

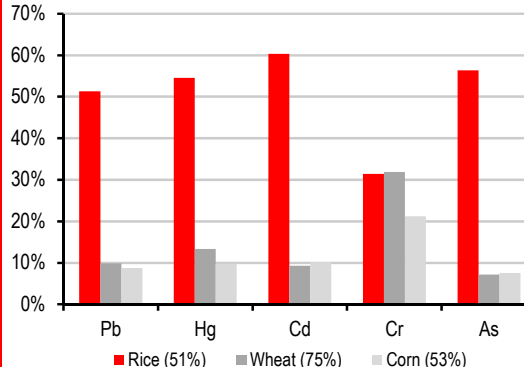
¹⁰ 12th FYP for Heavy Metal Pollution Control (2011)

Chart 7: Heavy metal discharge in 2012 by key provinces



Note: Brackets denote total national discharge in tonnes
Key: Pb = lead, Hg = mercury, Cd = cadmium, Cr = chromium, As = arsenic
Source: HSBC (based on China Water Risk, MEP, National Bureau of Statistics)

Chart 8: Heavy metal exposure of top 5 growers by key grain



Note: Rice (51%) = 51% of rice comes from the Top 5 rice producing provinces, etc.
Key: Pb = lead, Hg = mercury, Cd = cadmium, Cr = chromium, As = arsenic
Source: HSBC (based on China Water Risk, CEIC, National Bureau of Statistics)

Food safety is a concern when seven out of the top 10 agricultural provinces (by sown land) are amongst the top 14 heavy metal provinces. For example, of the top 10 agriculture provinces, Hunan accounts for 13% of China's total rice output – producing 26m tonnes in 2012. Hunan is also the top discharger of lead, mercury, cadmium and arsenic. Polluted rice was widely reported in the press in May 2013, when a government test found that almost half the rice for sale in Guangzhou was cadmium-tainted.

Rice is most exposed to heavy metals

Heavy metals are difficult to clean up. Soil remediation is a painstaking process (every parcel of soil); yet without it, heavy metals stay in the soil for a long time. The problem is when crops absorb the heavy metals and in turn these crops are ingested by humans. We find that rice is most exposed to heavy metal pollution, based on the analysis by China Water Risk (Chart 8).

High cases of cadmium pollution have led to cases of “soft bones” and reports of farmers not eating their own rice for fear of such pollution. The safety of rice, a staple of the Chinese diet, is clearly a significant concern for China. The government is acting to alleviate public concerns over food safety, especially to ensure social stability.

Soil pollution and food safety policies

The government issued a “Declaration of War against pollution” during the National People's Congress earlier this month. Pollution includes air, water and soil pollution. Interestingly, air pollution can also affect agriculture as smog blocks out sunlight and impedes photosynthesis.

We think soil pollution is more difficult to tackle, because air and water pollution can, in theory, clean itself up over time, but soil remains polluted for much longer and is more difficult to treat. That is why the soil law includes a remediation element.

Soil laws: Besides the new Soil Environmental Protection Law, the Soil Pollution Prevention & Remediation Action Plan is tabled to be announced in 2014, according to the MEP. Key measures include:

- 1 Protection of arable land,
- 2 Control of pollution sources,
- 3 Management of contaminated sites,
- 4 Soil remediation (pilot sites), and
- 5 Tighter monitoring and management of the soil environment.

Water laws: Given the close relationship between water and soil pollution, the soil aspect is also covered, albeit more loosely, through water and other policies, for example:

- 1 Revision of the Environmental Protection Law (including raising fines),
- 2 The Action Plan for Pollution Prevention and Control for Water (expected in 2014),
- 3 Prevention and Control of Pollution from Large-Scale Breeding of Livestock and Poultry (wastewater discharge standards for animal husbandry), and
- 4 Targeting water-intensive and polluting industries (with new discharge standards).

Food safety laws: Zhang Dejiang, Chairman of the NPC, announced this month that a revision to the Food Safety Law is also underway. Possible amendments under discussion include raising fines for violations, criminality (possible prison sentences for violators) and lifetime bans from operating in the food sector.

Similar to water – where quality affects quantity – food safety also affects food security. The food self-sufficiency policy leaves some room for imports, although imported food tends to be more expensive. The perception that imported food is safer, coupled with various food scares in China, has led more affluent members of society to increasingly turn to imports.

Food security worries the Chinese government

- ▶ Food demand is increasing in China, driven by rising affluence and urbanisation; Chinese diets are also trending towards more meat
- ▶ Ensuring food self-sufficiency is a top priority and requires collaboration across ministries (agriculture, land, water, energy and climate change)
- ▶ Besides tackling water shortages, food security strategies include changing the diet, consolidation of farmland and optimisation of yields

The changing Chinese diet

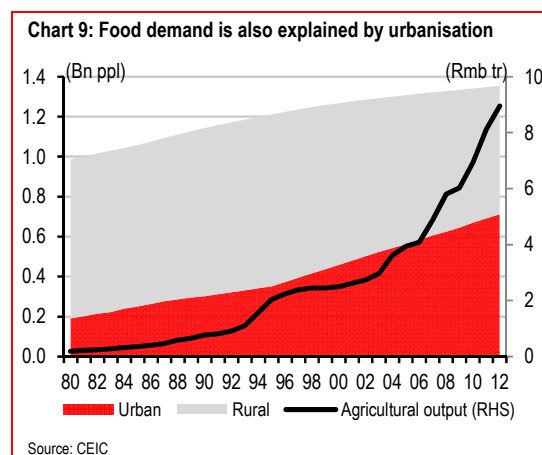
As incomes in emerging economies rise, diets tend to change in favour of finer foods. (For a detailed analysis of this at the global level, please see [Global agricultural commodities](#), 17 March 2014.) Here we look at the argument for changing diets in China not from an income perspective, but from an urbanisation viewpoint – and how this affects food security.

Urbanisation and food consumption

The contribution of agriculture to Chinese GDP has shrunk from one-quarter in 1990 to around 10% currently. However, the actual value of agriculture has been growing at 12.8% per annum since 1980 – from RMB192bn to RMB8.9trn. During this time, per capita GDP grew at 15% per annum, but the population only 1.0% per annum, whilst the number of city dwellers grew at 4.2% per annum.

China's city dwellers have risen from 191m in 1980 to 712m in 2012. This migration of 521m to Chinese cities is roughly equivalent to adding 1.6x the whole population of the United States.

Urbanisation exceeded 50% in 2011, and by 2012, there were 70m more people living in cities than in rural areas.

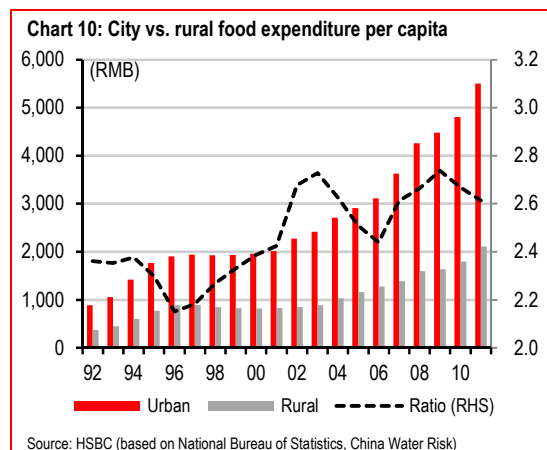


Coupled with rising affluence, we think the rise in food demand can also be partially explained by a rising urban population (Chart 9).

City dwellers tend to eat more

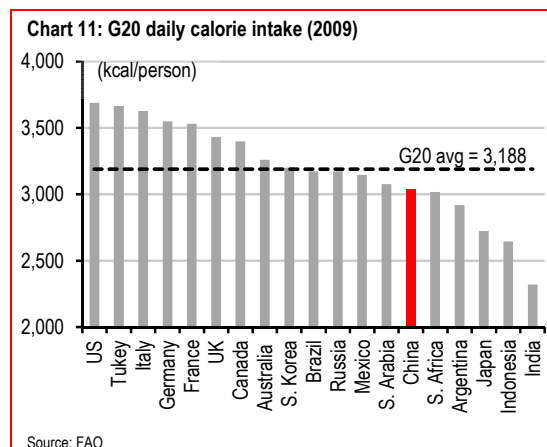
In China, city dwellers spend an average of two and a half times more on food than their rural counterparts. This ratio has been fairly consistent

over the past two decades, but it is showing signs of a long-term increase (Chart 10).

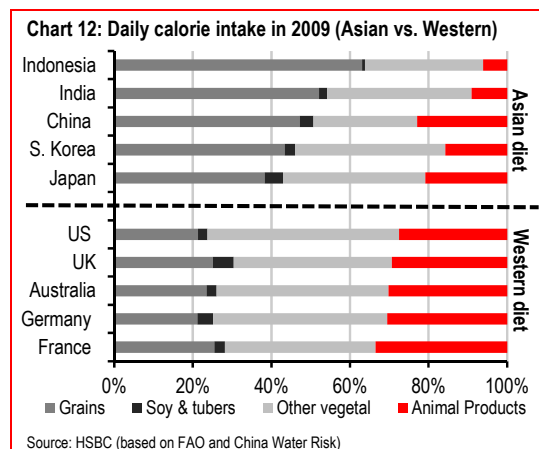


China's rising calorie count

Currently, the average Chinese diet is 3,036 kcal/person/day. Although this figure is already within the WHO-FAO guidelines of 1,813-3,573 kcal/day (depending on gender, weight and age), it has more room to grow compared to the G20 average of 3,188 kcal/person/day (Chart 11).

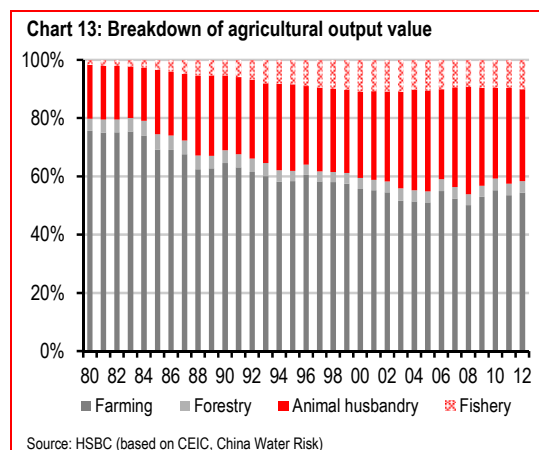


Comparison of diet mix within the G20 peer group shows that the Asian diet is more grain-intensive (Chart 12). Amongst Asian countries, Japan consumes the least grains, followed by Korea and then China. Western diets tend to contain more meat and there is evidence that the Chinese palate is trending towards more meat too.



More protein, more meat

Protein within the Chinese diet has been rising over the last 30 years. Protein output from fisheries has been growing at 19% per annum and from animal husbandry at 14.5% per annum since 1980. This is in line with our findings on more meat in diets as incomes rise (see [Global agricultural commodities](#), 17 March 2014).



The contribution to agriculture from farming (i.e. growing crops) has fallen to 54% in 2012 from 76% in 1980 (Chart 13). Meanwhile, the contribution of meat (animals and fish) has more than doubled from 20% to 42%. We expect this trend to continue as Chinese incomes and the number of city dwellers continues to rise.

Food security a top priority

Agricultural self-sufficiency has been one of the top priorities for China over the past decade. We think this will continue, given the large contribution of food to China's CPI basket (around one-third). Reforms targeting the "san nong" (三农) of agricultural sector, rural areas and farmers became a top policy priority in 2004. The refocus became apparent after China's grain yield fell consecutively for five years following the nation's preparation and entry into the WTO in 2001.

The No.1 Document, the first policy document issued by the central government each year, has been focused on the "san nong" since 2004 (Table 1). The only partial exception was in 2011, when the No.1 Document focused on water; however, we suggest that this was still with "agriculture in mind" because of its importance to the sector.

Table 1: No.1 Documents focused on agriculture since 2004

Year	Main theme of the No.1 Document
2004	Boost farmers' income
2005	Strengthen rural work and production capacity
2006	Construct a new socialist countryside
2007	Develop modern agriculture
2008	Fortify the foundation of agriculture
2009	Achieve steady agricultural development
2010	Coordinate rural and urban development areas
2011	"Three red lines" for water conservancy - Control total water use, efficiency and pollution - Improve water infrastructure - Water tariff reform
2012	Scientific and technological innovation to boost yields - Accelerate water conservancy; increase irrigated area - Promotes safe and effective fertilisers and pesticides
2013	Modernise agriculture and strengthen the rural economy - Water savings and water efficiency in NE China - Accelerate land reform; rural subsidies to develop large-scale farming
2014	Ensure food security by improving the rural environment - Minimum arable land at 120m ha to ensure grain security - Pursue "basic grain self-sufficiency" whilst increasing the use of overseas markets - Revolve environmental constraints

Source: China Water Risk (based on various government websites)

The No. 1 Documents also highlight the importance of water use and water efficiency in agriculture. The priorities of maintaining food security and improving the rural environment are reiterated in 2014's No.1 Document, with the

recognition that environmental constraints such as water shortages and pollution affect agriculture.

Ensuring food security

The importance of food security means it must be tackled from all angles – not just growing more. Government policies, which affect food, involve all parts of the water-food-energy nexus. For example, water policies elsewhere determine the water availability (in sufficient quality) for agriculture, changing the demand (diets) and supply (higher yields) of food, how land is earmarked for energy (coal bases), and the water it uses; and also how national trade might change in light of these factors. We have discussed water shortages earlier; here we look at the following in more detail:

- ▶ Changing the Chinese diet,
- ▶ Land reform and consolidation, and
- ▶ Optimisation of yields.

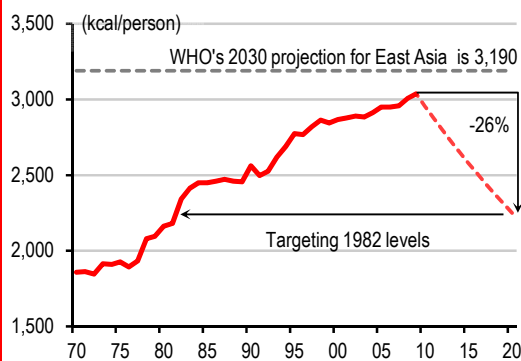
Changing the Chinese diet

According to the FAO¹¹, agricultural production growth must rise faster than population growth – to feed the impoverished but also to satisfy an increasingly affluent population. The FAO said that an additional 1bn tonnes of cereals and an extra 200m tonnes of livestock products are needed to support the global population by 2050 – prompting many to suggest that vegetarian diets are the way forward.

Incidentally, the Chinese government is beginning to have the same thoughts: combating the rising propensity towards meat by controlling diet mix (and save water at the same time). This year, it issued New Guidelines on China's Food and Nutrition Development (2014-20). It suggests that the Chinese population should not only reduce its daily calorie intake by 26% to 2,200-2,300 kcal/person but the mix should be: grains >50%, fats <30%, and 78g of proteins.

¹¹ State of the World's Land and Water Resources for Food & Agriculture, FAO, December 2011

Chart 14: China – dieting to get back to its 1982 self?



Source: HSBC (based on FAO, China Water Risk, State Council)

This decline contrasts with the WHO forecast of a world daily per capita intake of 3,050 kcal by 2030 – with projections for East Asia at 3,190 kcal (Chart 14). We believe that this calorie reduction is an attempt to ensure food security (given rising affluence, urbanisation and limited land resources) and slow down the rate of growth of meat demand (by moving away from water-intensive proteins). Table 2 highlights just how water-intensive meat is versus grains.

Table 2: World average virtual water content in food

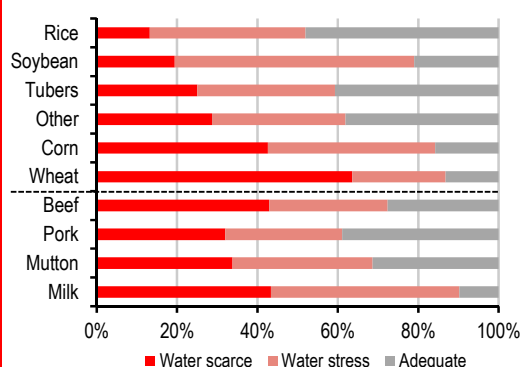
Food (per tonne)	Water (m ³)
Wheat	1,300
Rice	2,300
Pork	4,850
Beef	15,500

Source: China Water Risk

Exposure to water scarcity

An analysis of farm areas dedicated to different crops by China Water Risk found that lands sown with wheat and corn are most exposed to water risk. Some 64% of the arable land dedicated to wheat and 42% to corn is in water-scarce regions (Chart 15). Wheat and corn tend to be grown in the North of China, which is drier, whereas rice is mainly grown in the South. Almost half of rice is grown in water-rich provinces.

Chart 15: Breakdown of exposure to water availability



Source: China Water Risk, CEIC

From a meat (proteins) perspective, beef and dairy products are most at exposed to water scarcity. Over 40% of these water-intensive foods are produced in water-scarce regions. We think the government's desire to shift towards a more grain-based diet could be driven by the water-intensity of growing meat and the lower water availability in regions where animals are raised.

Land reform and consolidation

We discussed above that China officially has 135m ha (203,077 mu) of *arable land* but 163m ha of *sown area*.

Definitions

Arable land: is defined as land to grow crops, including cultivated, newly developed, restored, consolidated or fallowed land.

Sown area: is defined as an area of land sown or transplanted with crops regardless of being in cultivated or non-cultivated areas.

Mu: is the Chinese measure for area; there are 15 mu to the hectare.

Ensuring grain sufficiency requires land

Ensuring grain sufficiency is not straightforward, given water availability, land use (urbanisation) and pollution issues. It requires a minimum amount of land. This year's No.1 Document (see Table 1 on page 16) sets aside 120m ha of arable land for growing crops. In addition, once this land has been designated as arable land, it is under

permanent protection and cannot be used for other purposes.

In 2012, the State Council¹² stated that the grain crop area should stay above 107m ha to produce at least 540m tonnes of grains by 2015. Of the 163m ha of sown area, some 111m ha is sown with grain crops, mainly rice, wheat, corn, soybeans and tubers (Table 3).

Table 3: Breakdown of sown area by grain/crop

Crop	Sown area (ha m)	% of total	Change (2012-1980)	CAGR
Corn	35	21.4%	74.39%	1.75%
Soybeans	10	5.9%	34.36%	0.93%
Rice	30	18.4%	-11.04%	-0.37%
Wheat	24	14.9%	-15.86%	-0.54%
Tubers	9	5.4%	-12.48%	-0.42%
Other Grain	3	1.9%	-81.38%	-5.12%
Sub-total	111	68.1%	-5.14%	-0.16%
Other Crops	52	31.9%	79.14%	1.84%
Total	163	100%	11.64%	0.34%

Note: Other crops include – oil bearing, cotton, fibres, sugars, tobaccos, teas, etc.
Source: HSBC (CEIC, China Water Risk)

In total, China's sown area grew by 17m ha since 1980 to 163m ha in 2012. This increase was primarily driven by corn and soybeans, which have seen their areas grow, whilst other grains such as rice, wheat and tubers saw a contraction of sown area. It should be noted that the soybean-sown area peaked at 13m ha in 2001 and has since fallen to 9.7m ha in 2012.

Animal feed – grains for meat

We think the expansion in the sown areas of corn and soybeans since 1980 reflects the growth in animal husbandry. The need for animal feed has driven the larger sown areas for soybeans but also the vast growth of imports. The import of soybeans has grown from virtually zero in the 1990s to over 63m tonnes in 2013.

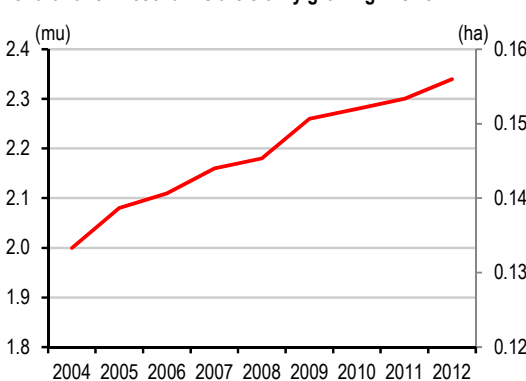
We think China will continue to optimise its grain mix by prioritising growing grains for human consumption, leaving grains for animal feed to be imported.

Land reform – moving away from small farms

Farms in China have traditionally been small, a few mu of land per household. However, small farming plots make it more difficult for the government to push through its agricultural reforms. For example, asking a small farmer to install irrigation technology may not be cost effective; asking small plots to improve the efficiency of irrigation or optimising fertiliser mix would require major educational drives. As such, China has been working towards increasing the plot size per farmer.

Farming plot sizes have increased in recent years, but are still relatively small, at 2.3 mu or under one-sixth of a hectare in 2012 (Chart 16). We expect this plot size increase to continue, given urbanisation (fewer farmers), tighter pollution control (costly), rising incomes and possible land reform. We think the sizes of animal husbandry farms should also grow steadily.

Chart 16: Chinese farms are slowly growing in size



Source: China Water Risk, National Bureau of Statistics

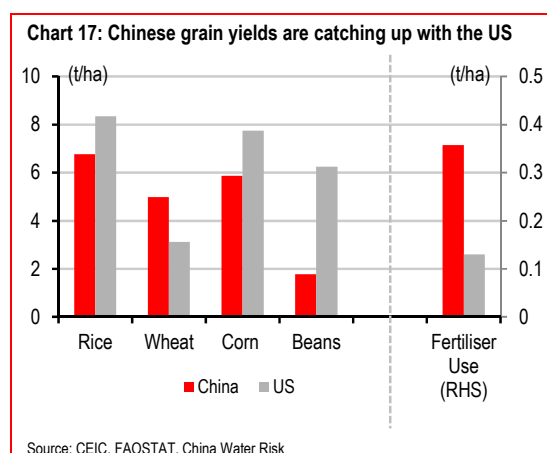
Plot sizes already differ between provinces. Farms in the North China Plain are in a range of 1.2-1.9 mu, whereas the average farm sizes in North-eastern provinces (Heilongjiang, Jilin, Liaoning and parts of Inner Mongolia) are larger, at 3.8-10.4 mu. As discussed, it is easier to implement irrigation technology, pollution control and fertiliser optimisation across larger farms. The No.1 Document in 2013 identified these North-eastern provinces for water saving and crop yield optimisation.

¹² Modern Agriculture Development Plan

Optimisation of yields

Less is more – using fertiliser more efficiently

We believe that the new pollution targets will slow down the fertiliser-fuelled yield improvements of recent decades. Whilst there is room for improvement, the yield of China's key grains is not too far off that of the US (Chart 17).



The chart shows that it is possible to do more with less – grow more grains using less fertilisers. Using fertilisers more efficiently, for example, through soil testing before application, as well as a better mix, is one of the techniques China is pursuing to improve yields, whilst cutting down pollution. *(It is worth noting that the higher US yields could be due to genetically modified or GM seeds, which China has been averse to planting, with the exception of non-food agricultural products such as cotton and flowers. Niu Dun, Deputy Minister for Agriculture, said in March that China needed to stay on top of GM technology despite not allowing the commercial production of any GM staple foods.)*

Coupled with the more efficient use of fertilisers, yields can also be improved using agricultural technology and hybrid seeds. This “bio-agriculture” technology features strongly in government policy since it was designated as a Strategy Emerging Industry (SEI) in 2012. The category has been broken down into bio-pesticides, bio-fertilisers,

bio-feeds and veterinary vaccines. Agricultural technology has featured in a number of recent No.1 Documents.

The food-water-energy nexus

We think these developments show that the government is definitely looking at agricultural policy through a “water lens”. However, energy is also closely linked to water and makes up the third pillar in the food-water-energy nexus.

We previously discussed the relationship between energy and water in [No water, no power](#), September 2012. Since then, the government has decreed the water-for-coal plan, where the development of China's large coal bases must take into account regional water availability. This is part of the ongoing balancing of water resources and needs between competing segments of the economy. Depending on whether the central and local authorities prioritise energy or agriculture within provinces (i.e. at the county level), arable land could feel increasingly pressured to be more water-efficient.

Balancing water availability with water needs, whilst ensuring food and energy security, will require both reform across sectors, as well as collaboration across different ministries. We have begun to see this during the recent NPC meetings in China, but we expect to see more in the future, especially during the 13th Five-Year Plan period (2016-20).

Provinces and trade

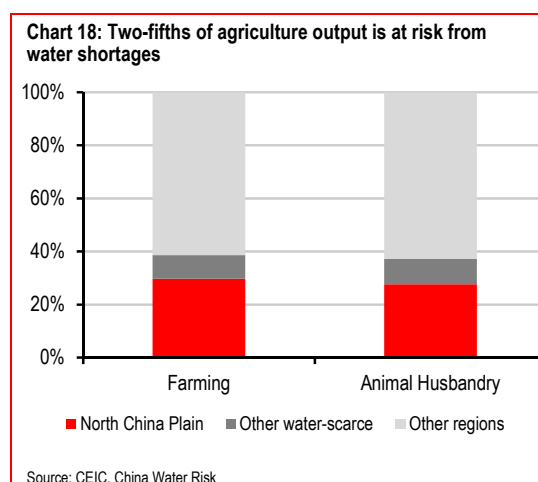
- ▶ The North China Plain comprises 28% of total agricultural output and 31% of fertiliser use but is reliant on groundwater and is water-scarce
- ▶ China could turn to imports to meet basic self-sufficiency, as well as guard against climate change and extreme weather
- ▶ Changes in China's consumption, the need to protect water resources and pollution control could affect global trade patterns

Agriculture and water scarcity

Here we take a closer look at the four provinces in the North China Plain and how changes in China could affect global trade patterns.

Water in the North China Plain

Water-scarce areas in China account for one-third of China's sown land and almost 40% of the agricultural output. In our view, the North China Plain is the most at risk region. In 2012, the provinces of Henan, Shandong, Hebei and Jiangsu accounted for 41.6m ha, or over one-quarter of China's total sown land, and almost 28% of total agricultural output.



The North China Plain is one of China's most important agricultural regions (producing corn, sorghum, winter wheat, vegetables and cotton), but it is also one where the groundwater is most at risk.

Reliance on groundwater is risky

A groundwater survey by the MLR showed that the North China Plain suffers from severe groundwater pollution, with more than 70% of overall groundwater quality classified as Grade IV-V (unfit for human touch). Only 22% of shallow groundwater and 26% of deep groundwater was Grade I-III (suitable for drinking or agriculture).

Map 4: Fertiliser use exacerbates the water scarcity problem by affecting water quality

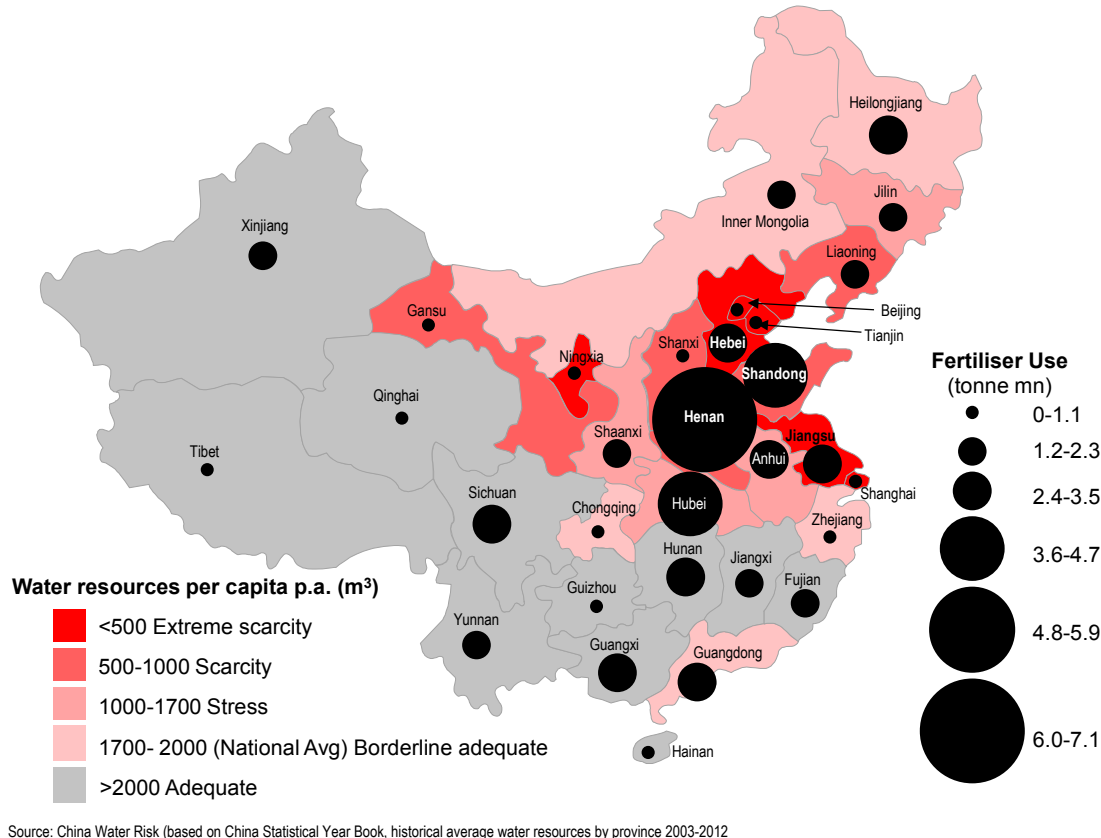
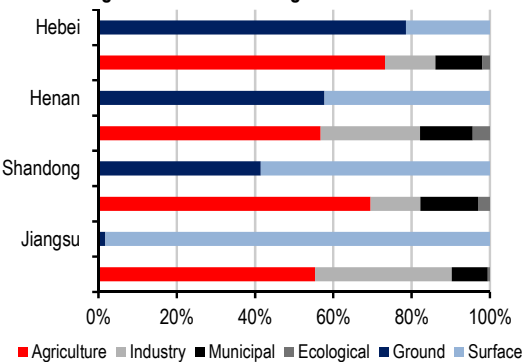


Chart 19: Agriculture is reliant on groundwater



This level of groundwater pollution is particularly worrying for Hebei, Henan and Shandong since these provinces are over-reliant on groundwater, compared with the national average of 21%. For example, in Hebei, groundwater supplies 77% of water resources, whilst agriculture consumes 73% of these water resources (Chart 19). It is a similar

situation in Henan. The over-extraction of groundwater in Northern China has been widely discussed as groundwater table levels have been declining in recent years.

Surface water is not safe either

However, reliance on surface water is not a safe strategy for agriculture either. As discussed above, the quality of water is affected by unchecked fertiliser use. Surface water is first affected through agricultural run-off into rivers etc.; however, over time this seeps further into the water table such that groundwater is then also affected. Almost four-fifths of China's total fertiliser use is in water-scarce provinces, with the North China Plain alone accounting for 31% of national fertiliser use (Map 4).

Production in the North China Plain

China is a major producer of key meats and grains globally, and the North China Plain is one of the key agricultural regions in the country. We briefly look at some key products.

Wheat: China is the top grower of wheat globally followed by India; the US is fourth. Production of wheat from the North China Plain in 2011 was more than one-tenth of global wheat production and greater than the entire wheat production of the US.

Maize: China is the second largest grower of maize after the US. Some 29% of its maize comes from the North China Plain – a similar amount to Brazil, which is the third largest producer.

Pork: Pig meat is the most produced meat in the world (107m tonnes) and China is the top producer by far, accounting for almost half of total global production. The North China Plain commands a 24% share of China's production, or more than one-tenth of global production – more than the entire US pig output in 2011.

Poultry: This is the second largest meat produced globally (94m tonnes) with China's 16m tonnes similar to the 19m tonnes from the US. Brazil is a more distant third, producing 10m tonnes. (*We were unable to find provincial levels statistics on poultry.*)

Beef: Cattle meat is the third most produced meat (66m tonnes globally) with the US the top producer. Whilst China's production is only half of that, over 30% comes from the North China Plain – which puts it on the same scale as Australia's beef production.

Mutton: Global sheep meat is produced in much smaller numbers at only 13m tonnes; however, with 30% of all the lamb in the world, China is the top producer. Almost one-quarter of China's lamb comes from the North China Plain with the output just shy of the combined Australia and New Zealand output.

Provincial scorecards

The enforcement of water quotas and pollution reduction targets at a provincial level is not an easy task. To encourage local authorities, the Work Plan on Implementing Assessment of the Most Stringent Water Management System was announced in February 2014. It incorporates water management into the performance evaluation of provincial leaders. Provinces that meet or exceed targets will be given preference in future projects (which is good for local GDP).

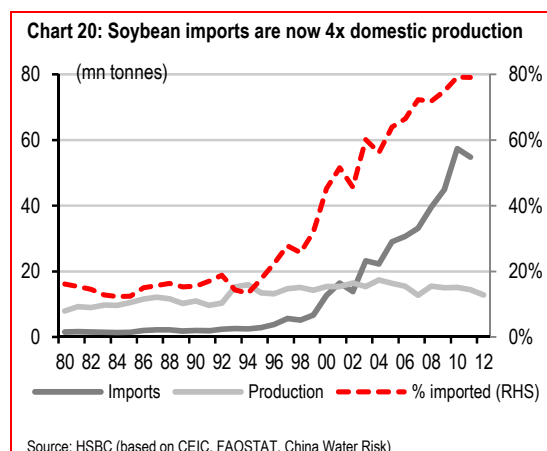
Changing trade patterns

China does not have a single large import partner for agricultural products, as such, a change in demand patterns (diets), water policies (nationally and in the North China Plain), and supply patterns (climate-disrupted output) could influence global agriculture trade.

Importing for animal feed

We discussed above that ensuring grain and food self-sufficiency requires land, but the crops grown in China have changed over time. Regarding self-sufficiency, we believe that grains grown domestically are more likely to be for human consumption, whilst China could turn to imports for grains to satisfy the need for animal feed.

For example, we look at soybeans as an animal feed. Imported soybeans in China are used for animal feed and to make oils (soy sauce). The sown area for soybeans peaked in 2001 at 13.3m ha and has fallen by 25% since then – because of China's entry into the WTO that year. However, soybean imports have risen 3.5x since 2001, which was also the year that imports overtook domestic production (Chart 20).



This fall in the soybean-sown area (since 2001) has worried the authorities, who do not want to see a similar pattern for corn – which is more important for human consumption.

Importing for “basic” self-sufficiency

China has expressed a desire¹³ to maintain grain crop production at 550m tonnes by 2020; current production is around 590m tonnes. The No.1 Document of 2014 stressed the need to pursue “basic” grain self-sufficiency, whilst increasing the use of overseas markets (i.e. imports). We think this would make sense, given the 40m tonne deficit projected by the 2020 production number.

As discussed above, the authorities would like the population to increase the grain mix within Chinese diets. Again, we think this “produce less but consume more” policy points towards more imports.

Importing for the climate factor

Agricultural output is reliant on natural resources, but changing weather norms because of climate change disrupt yields. For example, climate change impacts agriculture through destabilising rainfall patterns, although it is difficult to know how and where. However, agriculture is also a

perpetrator of global warming by contributing to total greenhouse gas emissions.

A warmer world – sub-optimal temperatures and water during the growing season impact harvest volumes. In a warmer world, crops may suffer due to increased evaporation and evapo-transpiration losses, as soil moisture gets lost more quickly, requiring additional water for irrigation.

Extreme weather – The China Meteorological Administration estimates that “in recent years, extreme weather such as floods, droughts, rainstorms and low temperatures has caused average grain losses of 50bn kg a year in China, with drought causing the greatest harm.” To put that in context, this is equivalent to 50m tonnes of grain, or approximately 10% of China’s annual grain output.

Any potential crop failures and yield erosion from climate-related events could lead China to import more food.

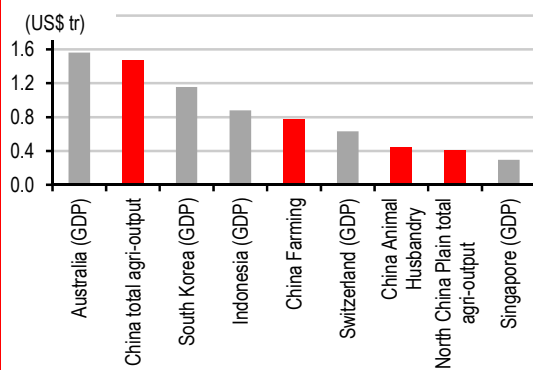
Importing for sheer size

Historically, China has been mostly able to feed its own population – such that it has no large single food trading partner. China’s agricultural sector (or primary industry) only comprises around 10% of GDP value; however, in terms of absolute value, it is large.

For example, China’s 2012 agricultural output value of USD1.5trn (of which the North China Plain is a large contributor) is similar to the GDP of Australia, its farming (grains, fruits, vegetables etc.) is almost the size of Indonesia’s economy, and its animal husbandry sector is 1.5x Singapore’s entire economy (Chart 21).

¹³ Guideline on China’s Food & Nutrition Development, State Council, February 2014

Chart 21: The sheer size of China's agriculture sector



Source: China Water Risk, CEIC, UN

The sheer size of the country, the anticipated rise in consumption (changing diets and urbanisation), changes in agriculture mix and policies, the strong need to protect limited land and water resources, as well as the clampdown on pollution, could mean that China increasingly taps into the global food markets through imports.

Changing global trade

We think that the importance of agriculture to the well-being of the country, for example, through employment and food security, is much greater than 10%. Therefore, we think policies to protect the industry, ensure food security and safety are likely to increase in the future. What happens in China could completely change historical patterns of the global food trade.

We look at some of the key importers and exporters of wheat, corn, beef and pork in the appendix.

A detailed discussion on trade and how regions producing finer foods may benefit more can be found in the HSBC report [Global agricultural commodities](#), March 2014.

Key trade themes

[Global agricultural commodities](#), March 2014, contains ideas to capitalise on some of the themes discussed in this report.

In summary, as middle class incomes rise in China, demand for dairy products is expected to increase, supporting Chinese dairy producers and countries like New Zealand. Demand for meat from Latin America, Australia and New Zealand is also set to rise. Brazil is expected to get support from sugar exports and Asian palm oil is set to see high demand.

HSBC's Climate Change reports

For more details on how climate affects agriculture, please see [Agriculture: Double Trouble](#), 12 December 2011.

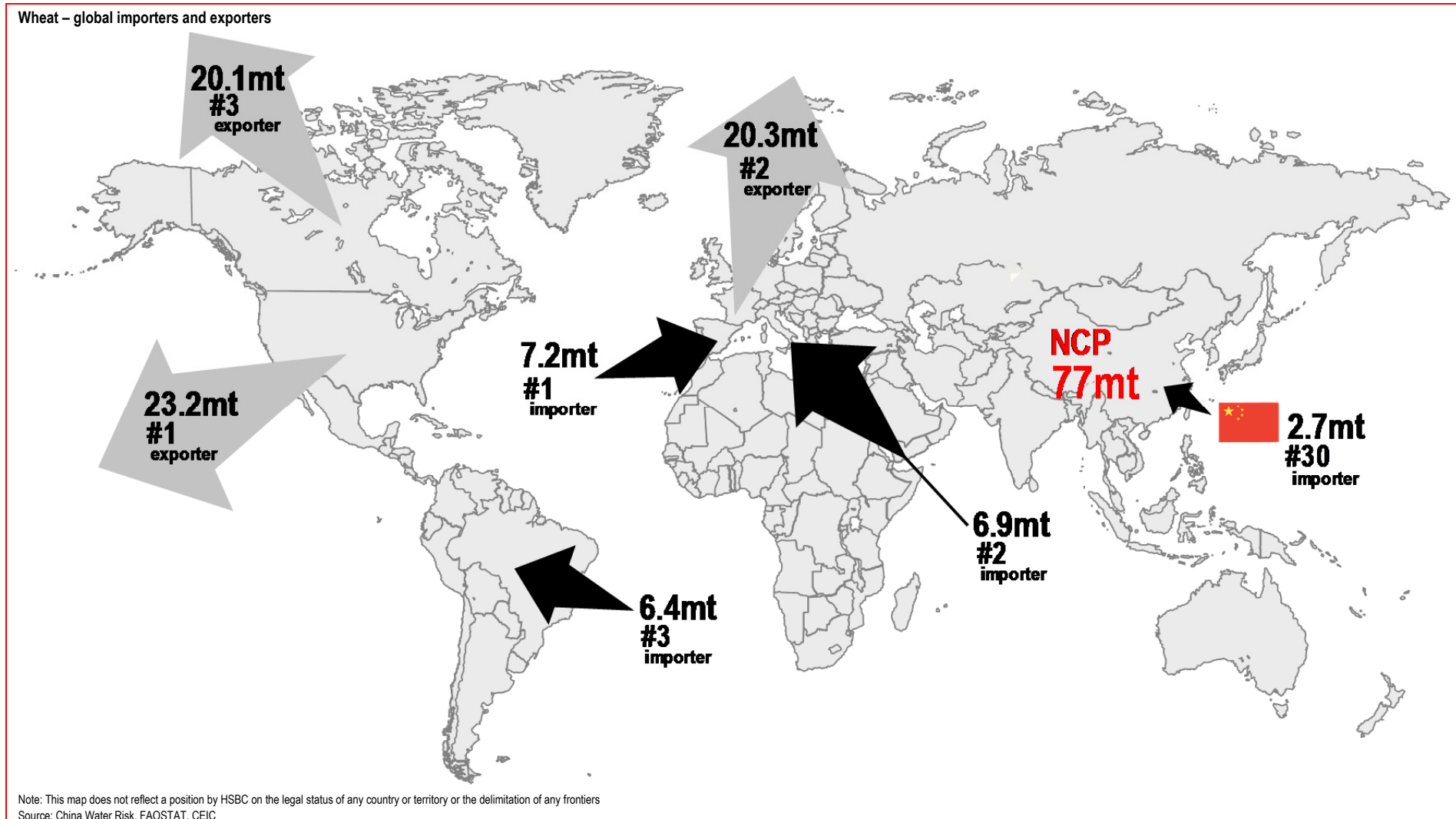
HSBC ranks China as the second most vulnerable to climate change in [Scoring Climate Risk](#) (9 August 2011, and updated on 24 September 2013).

For more details on climate risk in China specifically, see [China's rising climate risk](#) (6 October 2011).

Appendix

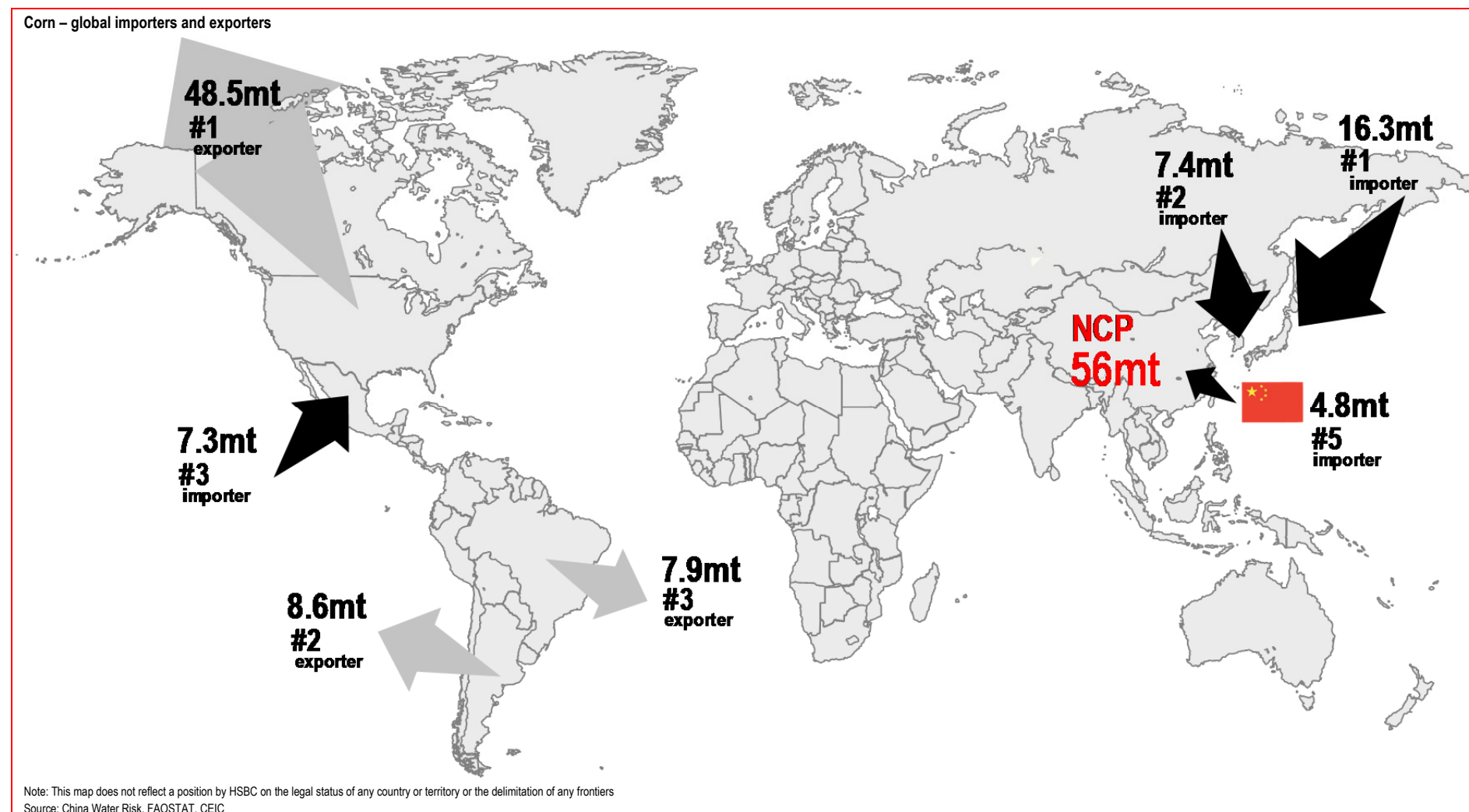
Wheat – global importers and exporters

Wheat production in the North China Plain (NCP) is equivalent to 43% of total global wheat export. A 10% shift in its output could completely change global trade



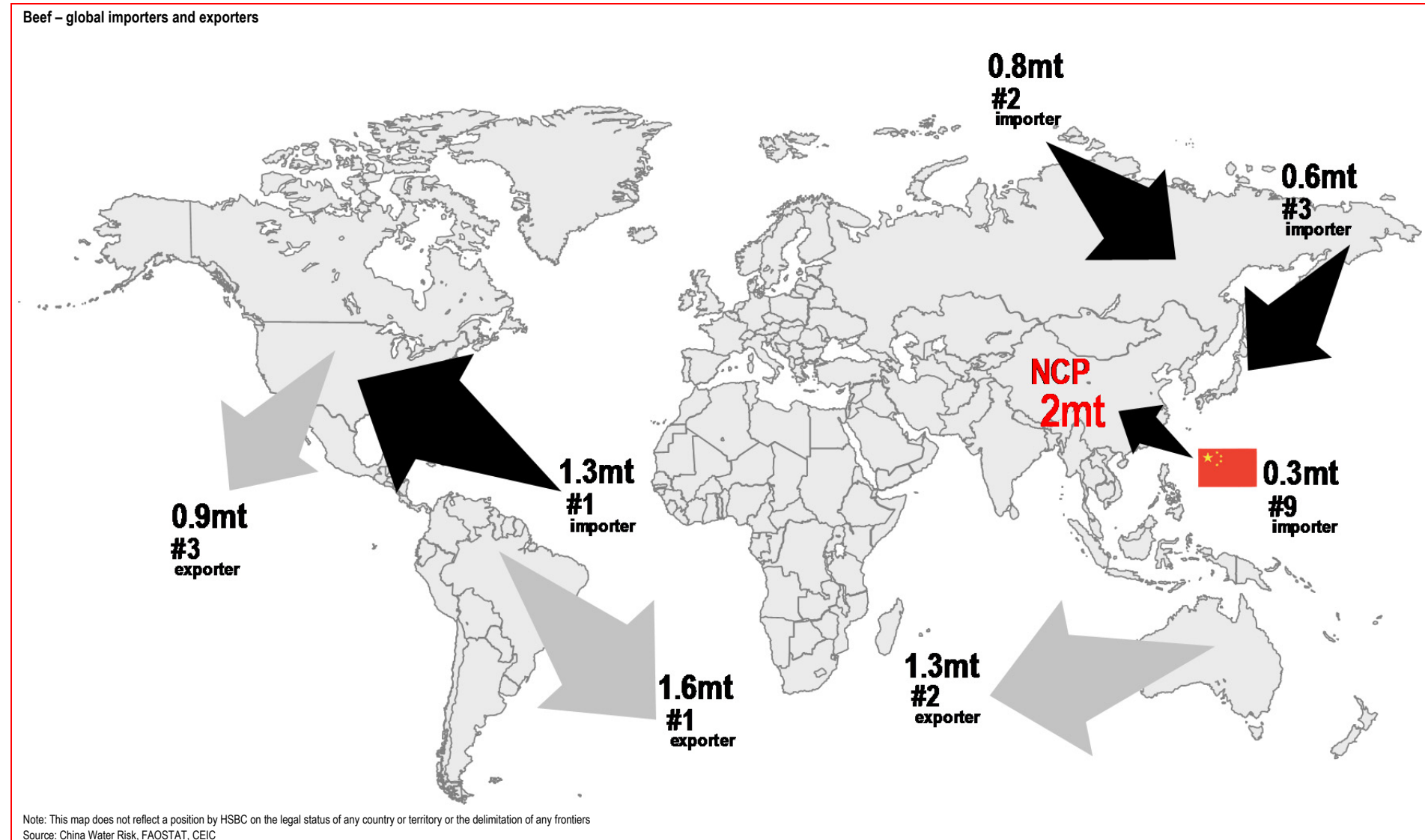
Corn – global importers and exporters

Corn production in the North China Plain (NCP) is equivalent to 54% of total global corn exports. A 10% shift in its output could completely change global trade



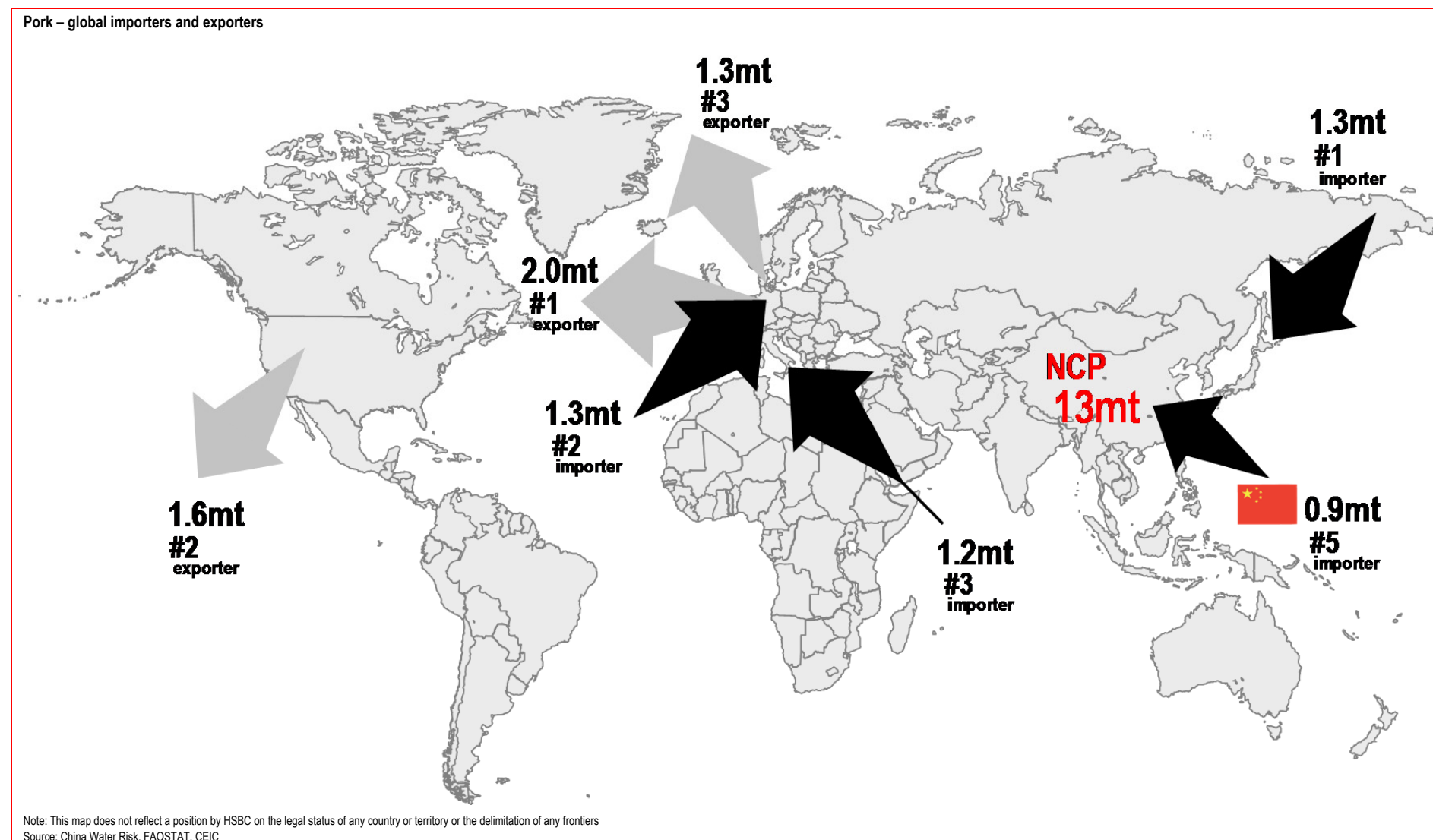
Beef – global importers and exporters

Beef production in the North China Plain (NCP) is equivalent to 20% of total global beef exports. A 15% shift in its output could completely change global trade



Pork – global importers and exporters

Pork production in the North China Plain (NCP) is equivalent to 98% of total global pork exports. A 5% shift in its output could completely change global trade



Notes

Notes

Disclosure appendix

Analyst Certification

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- 1 This report is dated as at 18 March 2014.
- 2 All market data included in this report are dated as at close 14 March 2014, unless otherwise indicated in the report.
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