Water Supply, Waste Water Treatment, Drainage and Flood Management

Water is one of the most important requirements of life. Since many urban areas in China are ‘water-scarce’, water management (water supply, waste water treatment and flood management) is an essential part of their ecological development. Thus a prime concern is the provision of quality drinking water, ensuring water safety for all (Tool WM 1: Water Safety Plans). The provision and distribution of water is a prominent factor in cities’ energy consumption, and new technologies can reduce energy needs. Immediately related to waste water is the treatment of waste water which can be done through sophisticated technologies or nature-based decentralised technologies (Tool WM 2: Waste Water Options). To address the issue of flooding through a holistic low-impact development (LID) approach, the ‘sponge city’ has been conceived which covers water harvesting through non-conventional methods, the nature based treatment of waste waters, and drainage and flood management through adaptive measures (Tool WM 3: Sponge City Planning).
Sector Profile of Water Management

Control and Management of water sources is a complex task, even in water-rich cities – Zhuhai

Pollution control is paramount to ensure water safety – Zhuhai

Wastewater treatment Plan in Hefei

Wetlands as part of the sponge city concept – Luoyang

Neighbourhood flood management through natural drains – Xixi’an District, Xi’an
Introduction. From a perspective of eco-city development, water supply cannot be limited to the simple supply of water in a specific location, its affordability or quality of service. From a perspective of resource efficiency, it is paramount to go beyond access to safe water – as a key requirement for safe and healthy living – towards maximizing the available water resources. Since drinking water has become a finite resource, the generation of water from non-conventional sources such as rainwater harvesting or recycling of water, i.e. the use of renewable and sustainable resource, will assume a new dimension in the future development of eco-cities. Rapid urbanization and climate change have impacted the quality of water resources and the patterns of supply and access. Demand-side issues involve more than just the provision of potable water: with increased population comes increased demand for water especially in the agriculture and industry sectors. There is a need to move from traditional water supply to non-conventional methods. Equally, waste water treatment, drainage and flood control need to be seen from their ecological dimension, and become part of an integrated system, or cycle.

State of Demand in China. Due to rapid and massive urbanization, water needs are increasing massively in China. Consumption levels have soared, particularly in cities and in better services new urban areas. However, the water supply situation is perturbed by water scarcity, and pollution and widespread contamination which has troubles many cities and the country side. There has been a big success in bringing piped water to the majority of households (about close to 100%), and even coverage of urban waste water treatment has reached high levels (about 90%). Water and waste water utilities are managed professionally and financially independent from city governments, but their fees are very low and they require subsidies for their operation. Much still need to be accomplished in the water sector, mostly in terms of making water drinkable on a 24 hours basis, and to provide full sewerage treatment coverage. The threat of increasing climate change impacts have led to the promotion of water conservation approaches under the “sponge city” concept which aims at water harvesting, water recycling and reuse.

Policy Directions. The Government’s pronouncement of the 13th Five Year Plan objectives has stated for the water sector: effective control of water consumption.¹

- **Build comfortable and livable environment.** Within 5 years … waste water shall be 100% collected and treated; for water deficient cities, the reclaimed water rate shall reach 20%.
- **Water Efficiency:** All buildings must have 100% adoption of cost-effective water saving appliances, and green spaces surrounding buildings must adopt low water-use plants. All water consumption should be metered and at least 20-30% of water supply must be recycled from either wastewater or rainwater.²
- **Smart Technologies can advance green development:** Save water through IoE technology and other water saving technology. Cities can improve water efficiency through smart storm and flood control equipment and water re-use.³

Best Practices in Europe. Water supply and sanitation in Europe is the responsibility of each member state, but in the 21st century union-wide policies have come into effect. Water resources are limited and supply and sanitation systems are under pressure from urbanisation and climate change, gradually there is a move for coordination. EU member states have enacted national legis-
lation in accordance with these directives. The institutional organisation of public water supply and sanitation does not fall under the purview of the EU, but remains a prerogative of each member state. Today, water supply and sanitation work is guided by the concept of water safety plans. Recent development, related to climate change, like massive flooding, have triggered new concerns for green infrastructure, such as drainage, which traditionally have been addressed through hard engineering solutions (capture, redirection, and discharge).

State of the art in water management in Europe.

Water supply. The EU has developed an extensive portfolio of water initiatives, water strategies, legislation and guidance, research findings and other information.  

EU Water Blueprint for Water Security. The water framework directive has been updated and focused on new water resource challenges by the EU Water Blueprint 2012. “The achievement of EU water policy goals is threatened by a number of old and emerging challenges, including water pollution, water abstraction for agriculture and energy production, land use and the impacts of climate change.” The Blueprint encourages a move towards what we call ‘prevention and preparedness’. It will ensure a sustainable balance between water demand and supply, taking into account the needs of both people and the natural ecosystems they depend on. The EU reacted to the increased risk of drought with the following initiative and formal communication to Member States. The 2012 Water Scarcity and Droughts Policy Review led to the “Blue Print for Safeguarding European Waters”.

EU response to the European Drought of 2003. Based on the periodical Follow-up results, assessment of the River Basin Management Plans and further information which has not been addressed so far, a Policy Review for water scarcity and droughts has been completed in November 2012.

River Basin Management Approaches. Integrated river basin management (IRBM) have been at the intellectual heart of the EU and Chinese approaches to water management, however, the maturity of approach and extent of application differ. The river basin approach is acknowledged in Europe as the best way to manage water.

EU Water Framework Directive. In 2000, the European Union took a ground-breaking step when it adopted the Water Framework Directive (WFD). It introduced a new legislative approach to managing and protecting water, based not on national or political boundaries, but on natural geographical and hydrological formations: river basins. These are known as River Basin Districts. IRBM needs clear coordination and collaboration between administrative authorities and stakeholders within the river basin. The WFD established a legal basis to protect and restore clean water across Europe and ensure its long-term, sustainable use. The general objective of the WFD is to make all water — for example, lakes, rivers, streams and groundwater aquifers — healthy. Through the WFD, establishes a key principle that all EU countries should move towards establishing ‘a full cost of water services’. This is the cost of abstracting water, treating it, pipe networks into the house and sewerage networks out. Also the cost of water treatment before discharge. The capital and revenue cost, plus borrowing costs must be taken into account in this ‘true cost of water service’. The EU-funded SWITCH (Sustainable Water Improves Tomorrow’s Cities Health) project has launched the concept of Integrated Urban Water Management (IWM) which explicitly proposes a combination of new paradigms in water management. These shall cover rain water harvesting, recycling and reuse of grey waters, and elements of low-impact development (LID), what in China is called the “Sponge City” concept.

Waste Water - The European Urban Wastewater Treatment Directive. Adopted in 1991, the European Urban Wastewater Treatment Directive (91/271/EEC) addresses the need to protect Europe’s groundwater, rivers, lakes and seas from the impacts of poorly treated wastewater. The Di-
rrective requires that all wastewater generated in areas with a population equivalent in excess of 2000 must receive at least secondary treatment. In addition, cities identified as being in vulnerable, or ‘sensitive’, areas face more stringent treatment requirements. The Directive is closely related to the European Water Framework Directive (2000/60/EC) which requires that all waters in the European Union achieve good ecological status by 2015. Despite being introduced almost 20 years ago, the Directive continues to pose a significant challenge for cities throughout Europe. In particular the more stringent treatment requirements for big cities located in ‘sensitive’ areas are still a major issue and 50% of the load from these cities is still being discharged without adequate treatment.\(^8\)

**Flood Control - EU Floods Directive.** The core European policy position on flood risk is the EU Floods\(^9\) Directive provides a common approach to flood risk across the EU. It entered into force on 26 November 2007. This Directive requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce this flood risk. With this Directive also reinforces the rights of the public to access this information and to have a say in the planning process. The Directive requires Member States to first carry out a preliminary assessment to identify the river basins and associated coastal areas at risk of flooding. For such zones they would then need to draw up flood risk maps and establish flood risk management plans focused on prevention, protection and preparedness. The Directive applies to inland waters as well as all coastal waters across the whole territory of the EU. Member States shall furthermore coordinate their flood risk management practices in shared river basins, including with third counties, and shall in solidarity not undertake measures that would increase the flood risk in neighbouring countries. Member States shall in take into consideration long term developments, including climate change, as well as sustainable land use practices in the flood risk management cycle addressed in this Directive. Approaches such as sponge-city, eco-city and Sustainable Urban Drainage Systems (SUDS) offer options to work with city planners to arrive at optimal and more sustainable solutions. However, in most cases, especially when applied to existing cities, these are in addition to conventional drainage infrastructure. There will always be a need to ensure public health with the proper collection and treatment of sewage through large base remover sewage treatment plants. Environmental sanitation and development of sewerage networks.

**Centralized versus decentralized systems.** Many cities have become oriented towards “high-tech” solutions of centralized collection and treatment systems. Water supply on the one hand, and waste water collection (sewerage system) and treatment are two sides of the same coin. Urban areas which lack the necessary infrastructure to collect, treat, and dispose of wastewater face numerous human and environmental health problems. Environmental sanitation is necessary for proper management of urban environments and to improve and protect human health as well as the natural environment.

The majority of cities focus on centralised water supply and sewage collection networks. These are an essential part of city infrastructure and these major water supply and waste removal systems are the backbone of public health provision. These centralised systems are usually developed and operated by municipalities, but in some countries these are privatized and operated by commercial organizations, with water charges being raised by the water companies to fund the provision. The trend is still to agglomerate water and sewage networks in order to optimize operation and reduce water charges. This is still the preferred model and commercial and competitive methods show this to be the case.

**Inadequate collection of waste water.** If sewerage networks are undersized or badly maintained then blockages and overflows occur. At worst this can cause sewer flooding and the backing up of sewage into households. Inadequate collection of waste water has a very strong impact on the natural environment. More so, the discharge of untreated effluent and industrial waste has strongly detrimental effects on the biology of watercourses and their ecosystem. Contaminated freshwater
sources, degraded aquatic environment, and eutrophication through excessive nutrient discharge are all outcomes of poor wastewater and surface water management. Coupled with these challenges, inadequate drainage and preparedness for heavy rain events often means that wet season and instances of high rainfall are compounded by poor or absent solid waste management and exacerbate the challenges that cities face in managing water resources, as it impacted by through localized flooding, contamination of water resources (through effluent combined fresh water).

**Design Standard for Sewage Treatment Works and Networks.** The EU outlines the minimum standards for sewerage systems and sewage treatment works through the Urban Waste Water Treatment Directive. It is a fundamental guide to determine acceptable minimum standards for sewage systems. The EU Council Directive 91/271/EEC concerning urban waste-water treatment, was adopted on 21 May 1991. Its objective is to protect the environment from the adverse effects of urban waste water discharges and discharges from certain industrial sectors (see Annex III of the Directive) and concerns the collection, treatment and discharge of (i) domestic waste water; (ii) mixture of waste water; and (iii) Waste water from certain industrial sectors.

**Compliance with the EU Urban Wastewater Treatment Directive (UWWTD).** Compliance against the UWWTD standards is one indicator used across Europe. Member States must report this to the EU.

**EU Flood Action Programme.** Aligned with the Floods Directive is the EU Flood Action Programme. This preceded the Floods Directive and was important in shaping the approaches. Flood risk management aims to reduce the likelihood and/or the impact of floods. Experience has shown that the most effective approach is through the development of flood risk management programmes incorporating the following elements:

1. **Prevention:** preventing damage caused by floods by avoiding construction of houses and industries in present and future flood-prone areas; by adapting future developments to the risk of flooding; and by promoting appropriate land-use, agricultural and forestry practices;
2. **Protection:** taking measures, both structural and non-structural, to reduce the likelihood of floods and/or the impact of floods in a specific location;
3. **Preparedness:** informing the population about flood risks and what to do in the event of a flood;
4. **Emergency response:** developing emergency response plans in the case of a flood;
5. **Recovery and lessons learned:** returning to normal conditions as soon as possible and mitigating both the social and economic impacts on the affected population.

**Sustainable Drainage.** Traditionally speaking, climate adaptation seeks to lower the risks posed by the consequences of climate change, including flooding caused by extreme rain events. However, when approached holistically it can also be used to address a number of other problems and create synergies to other areas of urban development. In this respect, Sustainable Urban Drainage Systems can play a key role in urban water management.

**The Precautionary Principle – EU definition.** The precautionary principle is detailed in Article 191 of the Treaty on the Functioning of the European Union (EU). It aims at ensuring a higher level of environmental protection through preventative decision-taking in the case of risk. However, in practice, the scope of this principle is far wider and also covers consumer policy, European legislation concerning food and human, animal and plant health. This Communication establishes common guidelines on the application of the precautionary principle. The definition of the principle shall also have a positive impact at international level, so as to ensure an appropriate level of environmental and health protection in international negotiations. It has been recognised by various international agreements, notably in the Sanitary and Phytosanitary Agreement (SPS) concluded in the framework of the World Trade Organisation (WTO).
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Source: F. Steinberg
Recourse to the precautionary principle. According to the Commission the precautionary principle may be invoked when a phenomenon, product or process may have a dangerous effect, identified by a scientific and objective evaluation, if this evaluation does not allow the risk to be determined with sufficient certainty. Recourse to the principle belongs in the general framework of risk analysis (which, besides risk evaluation, includes risk management and risk communication), and more particularly in the context of risk management which corresponds to the decision-making phase.

Waste Water Treatment. From the EU perspective, the focus is on continually improving methods and regulation that continuously drives innovation and new technologies. Overall the EU sets future targets in line with the evidence from the EEA and according to the EU Environmental Action Programme. Increasingly this follows an integrated approach, looking to optimise between Air, Land, Water and Waste, whilst preserving scarce natural resources.

Energy Capture from Sewage Networks and Treatment Plants. Digested sludge has been used to produce methane to power treatment works for many years. The processes are being progressively improved and optimized, in terms of the quality of the methane produced and the efficiency of the engines used to burn the methane. Sewage, water treatment and water pumping are energy intensive process so any methods to optimize this are important. These include, pump design, real time control systems and heat and energy recovery systems. The concept of carbon neutral STW is being developed, although none have yet reached this status. Significant development is continuing and this will be a major driver for future work, in terms of carbon reduction and cost saving.

Diffuse Pollution Control. One of the major challenges for environmental regulation is in addressing the sources and causes of diffuse pollution. Conventional engineering and permitting-based regulation works well for point sources of pollution, but has been ineffective at addressing diffuse sources such as pollutant runoff from agricultural practice, forestry, and urban hard surfaces. While in the EU there has been great progress in reducing point source pollution over recent decades, non-point / diffuse pollution, especially of nitrate and phosphorous from agricultural land, has generally remained stable or become worse. Awareness of this issue is often low with the majority of farmers not realising that they are major contributors to surface and groundwater pollution. There are often significant time lags between the application of fertiliser, pesticide or manures / sludge and its transport to rivers by surface or sub-surface routes. These will be dependent on weather, with site specific factors also affecting the pathways of pollutants to the receiving water.

Nature-based solutions. The EU has sponsored research on nature-based solutions as part of the EU innovation policy agenda. There is a growing awareness that nature can help to develop viable solutions which use and deploy the properties of the natural eco-systems, making them a new form of smart infrastructure systems, e.g. ‘engineering’ natural, ‘green’ and ‘blue’ solutions. These ‘nature-based solutions’ are designed to bring more nature and natural features to develop cost-effective, sustainable solutions. Green infrastructure can contribute to cost reductions, to reduction in energy use, can help to reduce heat island effects (through green roofs, green walls, decreasing heating and/or cooling needs). Co-benefits include reduced air pollution, flood control, and recreation. An integrated eco-system approach can provide cost-effective solutions for urban sustainability and resilience. 14

Best Practices. The practice of green water management in Europe is evolving rapidly, aided by smart technologies. Some of the most well-known European green water management experiences can be found in the following cities:

- **Copenhagen, Denmark**: Rain water Harvesting. The Danish project “The Soul of Nørrebro” won the Nordic Council of Ministers’ Nordic Built Cities Challenge. The challenge is aimed at the development and visualization of Nordic innovative solutions for livable, smart and sustainable cities. 15
Cardiff, United Kingdom: How a polluted bay became one of Europe’s best water fronts. To clean up the bay, the strictest environmental standards were applied — and still are. Diverting raw sewage to be treated before reaching the bay. Cardiff’s transformation isn’t complete. But it’s a far cry from the scenes of polluted desolation that gripped this place a generation ago.  

United Kingdom: engaging water customers in water saving. The concept of ‘push’ is about setting standards for water-using devices. Pull is about rewarding customers for using water wisely, and ‘Nudge is about understanding consumer behaviour and using it to promote change.  

Stockholm, Sweden: Waste Water Treatment Plant. Henriksdal wastewater treatment plant serves approximately one million people, and operated by the Stockholm Water Company. The facility is one of the world’s biggest underground WWTP. The project will enable the city to meet the effluent requirements set under the Baltic Sea Action Plan (BSAP) and EU water directive.  

EU: Sludge to power – Converting Human Waste to Power. There are thousands of sewage sludge digestion and biogas plants in Europe. However, properly integrated urban waste management schemes are rarer. The approach is an important for integrated solutions that have higher financial rates of return to the operators. These approaches will allow Local government to let Public Private Partnership contracts that will allow the construction of infrastructure for low carbon and sustainable solutions that are financeable in the long term even where public finances are severely indebted.  

London, United Kingdom: Thames water – Struvite / Phosphate Recovery. A state-of-the-art nutrient recovery facility that removes struvite, a compound containing phosphorus and ammonia, from sewage at Slough sewage works, turning it into premium-grade fertilizer.  

Berlin, Germany: Switching to Digital Control Technology in a Waste Water Treatment Plant. During its 20-year service life, Teleperm M enabled the reprocessing of 220 million m³ of wastewater per year at the Berliner Water Company’s wastewater treatment plants. The 104 automation systems have now been converted to the Simatic PCS 7 process control system, thus ushering in a new era at one of Europe’s largest water supply and waste disposal companies.  

Rotterdam, Netherlands: Resilient Rotterdam – Ready for the 21st Century. In 2030, Rotterdam will be a city where climate adaptation has penetrated into mainstream of city operations and water has added value for the city, the water management system is cyberproof.  

London, United Kingdom: Sustainable Urban Drainage Management (SUDs). SuDS provides an assessment of the capacity of urban areas, either already built or in the design phase, to be adapted to deliver better urban drainage responses and act as “Sponge Cities” for enhanced water resource utilisation and better water quality.  

State of the art in water management in China.

Water Use. The McKinsey Report “Preparing for China’s Urban Billion” concludes that: ‘Water Use is very likely to be a severe challenge, particularly for the Mega-cities in the North that will need water transfer projects to meet their needs. However, it is fair to note that most water consumption will still be in agriculture.’ The McKinsey Study has demonstrated that urban water use is only 4.1% of the overall water available. The challenge will not be the matching of demand and supply, but rather the geographical imbalance.  

Water availability. On a per capita basis, China’s water availability of 2,114 m³ per person (2003-2007) is very low, suggesting the potential for water stress as demand for usable water rises with growth in population and per capita income. Water pollution has further contributed to water shortages. To deal with the water shortages, the need to recycle water through more reliable and cost-
effective waste water and sewerage treatment, and more appropriate sewerage wastewater charg-
es.  

**Water price.** It should be noted that China’s business and domestic water price is far below a real cost, providing no incentive for water saving. Water tariffs in China are exceptionally low, with a cost of $0.5/m³, which ranks very low in an international comparison.

Access to an improved water source and improved sanitation has increased significantly in China over the past two decades in parallel with economic growth. Between 1990 and 2008 alone more than 450 million Chinese gained access to an improved water source, based on estimates by the Joint Monitoring Program for Water Supply and Sanitation of the WHO and UNICEF that are based on household survey data. Access to an improved water source was 89% and access to improved sanitation was 55% in 2008. Having access to an improved water source, however, is not the same as having access to safe water. Many of those who have access to adequate infrastructure suffer from poor water quality due to faecal contamination; high levels of naturally occurring fluoride, arsenic, or salts; and growing industrial and agricultural chemical pollution. Furthermore, seasonal water shortages occur.

**Waste Water Treatment.** According to statistics, 639 cities in China had flood control works, of which the cities with the flood control standard less than that of 10 years frequency accounted for 15.6%, and of which 403 cities did not meet the flood control standards stipulated by the state. The drainage facilities were not complete, and rainstorm waterlogging was an increasing prominent problem. In 2012, 184 cities in China were water flooded or waterlogged, and the mega cities, such as Beijing, Chongqing and Tianjin, suffered the most. The “Regulation on Urban Drainage and Sewage Treatment (herein after referred to as the Regulation), released according to Order of the State Council (No. 641), came into force on January 1, 2014. The Regulation … standardizes the planning, construction, maintenance and protection of urban drainage and sewage treatment facilities, and defines the legal responsibility of the relevant action entities. The Regulation proposes that urban drainage and wastewater treatment should follow the principles of respecting the nature, overall planning, construction of supporting facilities, safety, and comprehensive utilization, to embody the concept of ecological civilization and sustainable development. In order to solve the funding gap, it is especially stipulated in the Regulation that the state encourages franchising and government procurement of services and some other forms to attract social capital to participate in the investment, construction and operation of urban drainage and sewage treatment facilities.”

**Massive Programme for Wastewater Treatment.** Over the past 20 years, China has engaged in what is possibly the largest program to build wastewater treatment plants in history. Despite the substantial achievements of this program, many challenges remain. As per the 13th Five-Year Plan, sewerage processing capacity in cities reached 91% in 2015, and it is projected to reach 95% by 2020.

**Water Pollution.** In April 2015, the government declared that will wage a war against water polluting industries. This was declared in spite of fears that local governments and industries would oppose the move towards more environmental control of polluting industries, due to cost increases. This move will mean the levying of heavy fines for polluters, and the threat of eventual shut-down of industries. The government is convinced that positive impacts of greener and cleaner industries will eventually translate into a tremendous growth as the iron and steel making industries will become internationally competitive, and that benefits reaped could be in the order of 5.7 trillion RMB ($910 billion), in the industrial sector, and 3.9 million non-rural jobs. The Action Plan for Water Pollution wants to contribute to make more than 93 % of water drinkable. Factories which are too weak to comply with these regulations will be shut down from 2016 onwards.
From 2016 onwards, the government planned to establish a blacklist of polluters. The amount of black and smelly water in urban areas will be reduced to 10% by 2020, and should largely disappear by 2030, according to this Action Plan for Water Pollution. To reach these goals, outdated production capacity will be phased out in water polluting industries, the efficiency of water use will be increased, and market forces will be allowed to further optimize water consumption. The greening of the water sector is considered to become a possible additional engine of economic growth.

**Surface Water and Flood Control.** In recent years, heavy rains, floods and gradually evolved into a chronic disease of large and medium cities. Today, 99% of Chinese cities are in the fast discharge mode. Rainfall on the hardened, impermeable ground only relies on fast discharge through pipes. When there are strong rains, quickly it is obvious that under-dimensional pipes are not enough.

Many of the cities do have serious shortcomings in water supply, but rain water is usually just quickly drained away.

**Sponge City Initiative.** China has developed a strategic initiative to reduce surface water flooding and improve water resource security. It is known as the Sponge City initiative. The sponge City initiative aims to show that urban drainage and water shortages could be turned around to harvest this wealth of the existing water resources. Thus, the concept of the sponge city, is an analogy of ecological water management: rainfall can be absorbed locally or nearby, be saved in storages, infiltrated, purified, and used water can be fed back into the groundwater after (decentralized) cleaning. The concept will allow improved regulation of the water cycle: in drought when water is in short supply, it can be released, and it can be stored when in oversupply. The construction of sponge cities implies a reversal of concepts. Traditional city-building has used too many hard surfaces with fast run-offs of water. At the time of rain, this relies on drainage infrastructure, pumping stations and other "grey" facilities for drainage which mean to eliminated water excess rapidly, instead of being conducive to its usage.

Eco-city development should give emphasis to soft surfaces (permeable surfaces), such as grass, rain gardens, sunken green spaces and other "green" measures to organize drainage to slow the draining and release, of water. It suggests decentralized control of the water and waste water.

The physical implications of the "sponge city" concept would be a series of water bodies - rivers, lakes, ponds, green spaces, gardens, permeable pavements, and cavernous underground structures for water storage. While this concept may be feasible in new districts ("greenfield" development), in urban renewal ("brownfield" development) it is more complicated and costly to introduce, as observed by the China Academy of Urban Planning and Design. Nevertheless, there exist ideas about the application of the sponge concept in historically grown built environments, through rain gardens, sunken green, combined roads-cum-green belts, permeable paving, and green roofs. "Business as usual is no longer the way to think about urban water. An integrated water management approach is, from an overall perspective, the most cost-effective route in dealing with urban water and climate challenges."

**Proposed Water Management Key Performance Indicators (KPIs)**

<table>
<thead>
<tr>
<th>Indicator Category</th>
<th>Indicators: indicative values</th>
<th>Current achievements / Time frame for accomplishment</th>
</tr>
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<tbody>
<tr>
<td>Quality of water bodies [1]</td>
<td>Grade IV surface water quality</td>
<td>By 2020</td>
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<tr>
<td></td>
<td></td>
<td>standard GB 3838-2003 [1]</td>
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<tr>
<td>2</td>
<td>Water quality at centralized source reaches standard [2]</td>
<td>100% [2]</td>
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<tr>
<td></td>
<td>Water from taps with drinking water quality [1]</td>
<td>100% [1]</td>
</tr>
<tr>
<td></td>
<td>Drinking water Grade III standard [3]</td>
<td>100% [3]</td>
</tr>
<tr>
<td>4</td>
<td>In buildings: adoption of cost-effective water saving appliances</td>
<td>100% [4]</td>
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<tr>
<td></td>
<td>Water leakages as per standard CJJ92</td>
<td>≤8 % [5]</td>
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<td>5</td>
<td>By 2013 [1]</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Rate of reuse of reclaimed water (%) [2]</td>
<td>In water-scarce areas ≥25%; in areas without water scarcity ≥15% [2]</td>
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<tr>
<td></td>
<td></td>
<td>≥60% [6]</td>
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<td></td>
<td></td>
<td>Water deficient cities: ≥20% [7]</td>
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<td>7</td>
<td>Domestic water consumption [1]</td>
<td>≤ 120 liters / day.pers.[1] Not higher than the average of lower &amp; upper limits of</td>
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<td></td>
<td></td>
<td>GB/T50331 [5]</td>
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<td>8</td>
<td>Water supply from non-traditional sources [1]</td>
<td>≥50% [1]</td>
</tr>
<tr>
<td>9</td>
<td>Water permeability of surface areas [8]</td>
<td>≥85% [18]</td>
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<tr>
<td></td>
<td></td>
<td>≥10% [5]</td>
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<td></td>
<td></td>
<td>≥50% [8]</td>
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<tr>
<td>12</td>
<td>Grey water treatment and reuse</td>
<td>50%</td>
</tr>
<tr>
<td>13</td>
<td>Sponge city infrastructure contributes to water harvesting</td>
<td>30% of water supply</td>
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<tr>
<td>14</td>
<td>Drainage and sponge city measures eliminate urban flood events</td>
<td>100%</td>
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<td></td>
<td>By 2013 [1]</td>
<td></td>
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<td></td>
<td>By 2020 [4]</td>
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<td></td>
<td>By 2020 [4]</td>
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Sources:
Outlook and future sector agenda. Water supply needs to be linked to city master plans. For this Chinese cities will need to develop long term water strategic plans taking into account supply and demand balance and options to reduce risks. Quality water supply needs to be planned for, costed (based on a cost-recovery concept) and required infrastructure be developed in a phased manner. Through regulation cities need to ensure that water is not polluted and is fit for use.

 Provision of high quality sanitation for all – in homes and through public toilets in the interim, will require an assessment of current infrastructure and sewerage systems, especially combined sewer overflows and foul sewage discharges. The old practice of untreated discharges will have to come to an end. At the same time, municipal sewage treatment has to take into account provision and future need of improved water resources and environmental clean-up. Ecological monitoring programmes need to be created which cover water sources, discharges and receiving environment. In the case of industrial pollution, the condition of water resources needs review, including rivers, their impacts on city systems (upstream and downstream). Much more needs to be done to monitor and enforce regulations and permits. The environmental protection and improvements to water resources should be considered: biological and fish monitoring can be used as public focus for water resource improvement. Improvements to recreation, in and near water and possible bathing waters.

 For integrated drainage and flood control, cities need to ensure that new development plans incorporate sponge city concepts and water sensitive design. This links into cities’ climate change adaptation strategies. They need to take into account changing weather patterns, sea level rise and population growth, and have to consider flood mitigation and the use of ‘making space for water’ options. River restoration and ‘soft’ engineering will improve habitat potential for citizens and wildlife.

 There is increasing need to engage stakeholders in the water planning process. Engage other Ministries especially Ministry of Water Resources and Ministry of Environmental Protection as they have responsibilities for elements of water planning and delivery. Engage key business and property developers, also community leaders and general public. Will need to develop knowledge and capability in the city planning department and key stakeholders to achieve this

 For the sake of financial sustainability, a key objective will be to move away from the dominant subsidy culture, and strengthen water economy: There is considerable potential to utilise economic instruments and incentives to assist change. They must be used to complement good regulatory practice and to reinforce change. Water should be self-financing and a goal should be to move towards society paying full cost of water service. Water tariff structures can reduce demand and waste. Inward investment may help finance and mechanisms to assist in expensive and core infrastructure provision may be needed. Cities can consider privatisation and other financing mechanisms. Benefits assessment methods and understanding will assist in developing the business case, but not all can be monetized.

 Lastly, staff development and capacity building are fundamental to implement this approach of modernisation of the water sector.
Notes:

1 Extracted and translated from: http://www.gov.cn/zhengce/2016-02/21/content_5044367.htm
4 http://ec.europa.eu/environment/water/index_en.htm;
14 http://citiscope.org/story/2016/how-cardiff-turned-polluted-bay-one-europes-best-waterfrontsutm_source=Citiscope&utm_campaign=7e43e2709a-
   Mailchimp_2016_09_09&utm_medium=email&utm_term=0_ce992dbf6f-7e43e2709a-118049425
16 http://wpt.iwaponline.com/content/9/2/179
17 http://www.thameswater.co.uk/media/press-releases/17393.htm
19 http://www.100resilientcities.org/page/-/100rc/pdfs/strategy-resilient-rotterdam.pdf
20 http://www.thameswater.co.uk/about-us/2833.htm
25 It needs to be noted that China’s efforts to combat water pollution seem to be thwarted by poor data. See: Liu Qin. 2016. Clear as mud: how poor data is thwarting China’s water clean up. 18 May 2016. http://www.chinadialogue.org.cn/article/show/single/en/8922-Clear-as-mud-how-poor-data-is-thwarting-China-s-water-clean-up
http://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_China

30 UN-Habitat. 2015. *The State of China’s Cities 2014-2015*. Beijing. p. 85. http://unhabitat.org/books/%E4%B8%AD%E5%9B%BD%E5%9F%8E%E5%B8%82%E7%8A%B6%E5%86%B5%E6%8A%A5%E5%91%8A/the-state-of-china-cities/

31 UN-Habitat. 2015. *The State of China’s Cities 2014-2015*. Beijing. p. 81. http://unhabitat.org/books/%E4%B8%AD%E5%9B%BD%E5%9F%8E%E5%B8%82%E7%8A%B6%E5%86%B5%E6%8A%A5%E5%91%8A/the-state-of-china-cities/


36 Department of Housing, Urban and Rural development, Promoting the “sponge city”: The next big rain again will not “see the sea” http://www.eenews163.com/2014/11/03/department-of-housing-and-pushing-the-sponge-city-the-next-big-rain-again-will-not-see-the-sea-89687.html


38 These key performance indicators were prepared and compiled by the EC-Link Project. See: EC-Link. 2016. *Sino-EU Key Performance Indicators for Eco-Cities*. Beijing (unpublished draft).