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Fertilizer application and Non-Point Source Pollution problems between Uganda and China-Review

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Abstract

Non-point source pollution comes from diffuse sources in the environment primarily from agricultural areas draining water into a river, lake or sea. It is not only a problem to China but also many other countries in the world. Africa and in particular Uganda faces a similar problem but the extent needs to be ascertained. China's use of fertilizers and pesticides to boost food production stems back from 1970's. Uganda however has not yet reached at the level of using massive agricultural inputs. NPSP poses a big threat not only to the water habitats but also to the lives of people who depend on water from different surface water sources. This review paper looks at the current state of Uganda and China's surface water situation, water ecology, and areas severely affected by the problem, water use of China's major rivers and proposes policy intervention that the government can take in controlling the problem that if left with little or no attention can put the health of people and other users in a dire state. It also looks at Uganda's fertilizer situation in the East African region and lessons to learn from fertilizer heavy users like China to avoid similar problems. China's government has committed a great deal of resources in trying to control the problem but there is a lot that is still needed to take a reasonable stride to counteract the challenges that result from the problem among which may include extension education to rural farmers and other key stakeholders.

Keywords: Non-point source pollution, fertilisers, mitigation, eutrophication, green revolution, greenhouse gases

INTRODUCTION

According to Environmental Protection Agency (EPA), Non-Point source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters. In China and other countries, NPSP from agricultural and related activities is of major concern and poses a serious danger to the environment particularly surface water ecosystems. There is a challenge of feeding a large and increasing population with limited land for cultivation while attaining a clean and safe environment [13].

In 1950's there was an onset of "green revolution" that is increasing the use of fertilizers, pesticides and high yielding crop varieties. This became the principal means of increasing food production globally and China as well [8] China is now the leading user of synthetic nitrogen fertilizers in the world. The path that China has taken to boost food production has been successful in increasing and addressing food production concerns for her big and growing population however, it has created serious environmental consequences. The intensive use of agrochemicals has greatly contributed to emission of greenhouse gases like CH4 and N2H and entry of excessive nitrogen and phosphorus, pesticides and heavy metal pollutants in water bodies [27] leading to eutrophication. This has threatened life of aquatic ecosystems particularly fish and heavy metals have also been linked to human diseases as they are able to move along food chains. In Uganda, the problem exists especially in big lakes like Lake Victoria, Lake George and some of the other existing wetlands and rivers but on a small scale.

The objectives of this paper are: Understand Uganda and China in relation to fertilizer use and NPSP problems and be able to understand whether there is a reduction or an increase in NPSP in both countries. Through comparison of the NSP in these two countries, suggestions can be given to manage the NPS problems in the

NPS COMPARISON BETWEEN CHINA AND UGANDA

Water Ecology, pollution of Surface Water in China

At present, the damage and degradation of China's water ecology is very serious with commonly occurred issues of soil and water loss, reduction of aquatic biodiversity, river drying up, interruption by big dams, lake shrinking, wetlands destruction, water table depression, expansion of desertification, and salty sea water intrusion. In particular, the severe water scarcity and pollution has greatly reduced water body's ecological function and the value of its ecological services hence jeopardizing the sustainable socio economic development [4]. According to the data from the "Integrated Scientific Investigation of Soil and Water Loss and Ecological Security in China"jointly conducted by Chinese Academy of Sciences (CAS), Chinese Academy of Engineering (CAE), and Ministry of Water Resource [18], China is one of the countries having most serious soil and water loss in the world. At present, China's soil and water loss area is 3.57 million km^2 accounting for 37.2% of China's total land area, in which 1.931 million km^2 is under medium soil and water loss, and 1.122million km^2 suffers heavy soil and water loss. The soil erosion in the soil and water loss area is much faster than its formation. Since the 1990s, the dried up river course has become an aquatic ecological issue of common concern, especially in the North where the drying up of the river is quite common. In the seven largest rivers, Hai River is the first river experiencing zero flow. From 1980s through the beginning of 21st century, the zero flow has happened in all 21 rivers within the Hai River basin with an average zero flow time of more than 200 days, no guarantee of the basic ecological water in the river course. The zero flow happened in the Yellow River and is of most far-reaching influence. Since 1972 when the first zero flow occurred in the Yellow River, the frequency, duration, and length of river course of zero flow have been increasing. In 1997 the zero flow in the lower reaches of Yellow River lasted for 226 days. The zero flow has resulted in the reduction or loss of river's function and the degradation and damage of aquatic eco-systems, such as river eco-system, estuary eco-system, and the tail-end-lakes of inland rivers [3, 30].

Fertilizer Use NPSP in surface water bodies in Uganda and China

Fertiliser use in Uganda and East Africa as a whole

While the intensity of the fertilizer use has rapidly increased in other parts of the world, it has remained at a low level in Sub-Saharan Africa. For instance, while it has increased from 38 kg/ha in 1982 to 101 kg/ha in 2002 in South Asia, it increased little during the same period in Sub-Saharan Africa. This negligible fertilizer use partly explains lagging agricultural productivity growth in Sub-Saharan Africa [22].

Table 1: Fertilizer use in 3 different countries of East Africa, with special emphasis on Uganda

Country/ Survey year	Number of households	Proportion of inorganic fertilizer users (%)	Average quantity used (%)	Proportion of users by fertilizer type				Proportion of household that receive credit (%)
				DAP(%)	CAN(%)	NPK(%)	UREA(%)	
Kenya 2004	899	81	134	78	33	28	11	21
2007	777	78	121	70	19	25	8	18
Ethiopia 2004	417	74	104	71	-	-	71	44
2006	411	73	113	69	-	-	43	64
Uganda 2003	940	7	4	1	1	2	3	-
2005	936	8	7	3	1	4	3	-

Source: Adapted from Takashi Yamano et al., 2011

Generally, Fertilizer use in East Africa is still low but Uganda has very low number of farmers that use fertilizers in their farms. This is because farmers have little knowledge about its use, no credit incentives, high prices and lack of government initiatives to assist farmers by drafting a favourable policy and giving loans to farmers to uplift themselves from poverty. The total fertilizer consumption (in nitrogen fertilizer) remains at a low level, the 5-year average in Uganda is only 3,842 tons, which is about 5% of the Kenyan fertilizer consumption and 12% of the Ethiopian fertilizer consumption [9]

Fertilizer and pesticide use in China

Table 2: Shows increase in fertilizer use since 1949

Year	Total N+P2O5+K20 (In million tonnes)	Source of applied nutrients as % of total: Inorganic		Organic	
		Million tones	%	Million tones	%
1949	4.32	0.006	0.14	4.31	99.86
1965	8.68	1.94	22.4	6.74	77.6
1985	31.52	17.76	56.3	13.76	43.7
1990	40.86	25.90	63.4	14.96	36.6
1993	46.65	31.50	67.5	15.15	32.5
1995	52.95	35.95	67.9	17.00	32.1
2000a	60.28	42.02	67.7	18.26	30.3
2000b	66.31	49.73	75.0	16.58	25.0

Source: Lin Bao, 1995: Personal communication

As seen from Uganda's situation in table 1 above, China's case is very different. In 1949, inorganic sources of manure were contributing just 0.14% compared to organic sources which were contributing 99.86% however, this trend changed because China wanted to boost food production to address food insecurity. By 2000, China's agricultural use of organic matter resources was only 25% while the use of inorganic fertilizers was at 75%. China is now the biggest producer and consumer of synthetic N fertilizers in the world. This situation certainly explains the sharp differences in areas of food security, economic development and environmental quality deterioration in the two countries. It also explains why China's water quality in major lakes, rivers and ground water has deteriorated over the years [3]

China has been the world's largest consumer of pesticides [6]. In 2000, insecticides, fungicides, herbicides and plant growth regulators accounted for 54.7, 25.3, 19.3 and 0.7%, respectively, of the total consumption (Lin et al., 2000). With 4880 lakes covering a total area of 83400km^2 accounting to 0.8% of the country, most of them have been polluted causing eutrophication leading to serious algal bloom crisis in Dianchi lake in 2001 and Lake Taihu in 2007 [25]. In big rivers like Yangtze and Yellow river, nitrogen concentrations have been increasing in recent years [19]. The estuaries and coastal waters near cities are seriously polluted, and annual frequency of red tides has increased from 28 in 2000 to 68 in 2008 with a cumulative area of 13,738 km^2 [28].

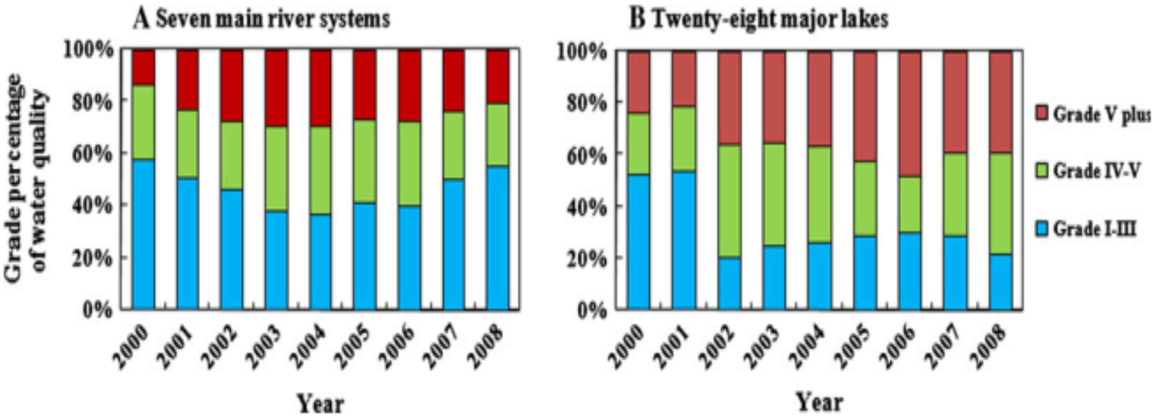

Figure 1: Water quality in seven major rivers (A) and 28 major lakes (B) in different grades in (%)

In addition, nitrogen concentrations in large rivers especially Yangtze and Yellow river have been increasing in recent years [19,32]. More than half of the rivers and about two-thirds of the lakes in the seven river systems and 28 major lakes were assessed to be of poor quality (Grade 1V and above) during 2000 to 2008 as seen in figure 1. Projections suggest that future nitrogen surplus from crop production will increase from about 154kg ha¬ in 2015 and hence the risk of NPSP will increase [26].

Pesticides like DDT are still a problem in many regions of China although residue levels have declined since 1983(Lin et al. 2000). The average concentration of DDTs and HCHs were 60µg kg (ND^3 ~ 2910 µg kg) and 8.7µg kg (ND ~ 131 µg Kg) in 2000s respectively. The average concentration of DDTs in the soils of East China was 14- and 5-fold of that of South and Southwest China, while the ones of HCHs in South and Southwest China were 4- and 2-fold of those in North China [2]. A survey that was conducted in 2003-2004 showed that out of 217 reservoirs and 406 rivers and lakes in seven major river basins, were moderately polluted by OCPs (Gao et al. 2008). Lindane (y-HCH) and p,p^1-DDT were detected in 84 and 63% of sites, with a mean concentration of 0.0313 μg L-^{1} (ND ~ 0.860 μg L) and 14.6 lg L-^{1} (ND ~ 0.368 μg L-^{1}) respectively. The concentrations of HCH in the rivers of northern China were usually higher than those of southern China. The surface water with the highest concentrations of HCH and p, p0-DDT occurred mainly in the Yellow River and Huaihe River basins.

In Uganda, water pollution exists and various studies have been conducted in major open lake basins and a number of pollutants like copper, cobalt and chromium, Lindane have been found to exist though in quantities that is within acceptable standards [24]. Pollution of heavy metals comes from mines in the hills draining into the Nyamwamba River catchment and at the processing plant near Kasese where the ore was crushed and copper extracted. The tailings, which are rich in cobalt sulphide, are stacked near to the processing plant [24]. Lake Victoria, the world's biggest lake is among the lakes affected by this problem majorly from anthropogenic sources. Lake George and Lake Edward also are affected by metal pollutants.

In addition, there is organochloride pesticide contamination in these water bodies that are as a result of increased agricultural productivity to meet the increased demand for food of the increasing population [23].

Table 3: Concentration of organochlorides in surface water samples of L. Victoria basin

	Concenteration, μg L^{-1}					
Compound	Katonga		Simiyu		Nyando	
	Range	Mean	Range	Mean	Range	Mean
Endosulphan alpha	0.002-0.004	0.003	0.040-0.042	0.041	0.030-0.038	0.034
Endosulfan beta	0.011-0.013	0.012	0.048-0.052	0.050	0.030-0.032	0.031
Endosulfan sulphate	0.34-0.042	0.038	0.073-0.075	0.074	0.015-0.019	0.017
DDD-pp	0.280-0.0.320	0.030	0.033-0.37	0.070	0.012-0.016	0.014
DDT-op	0.026-0.03	0.028	0.027-081	0.054	0.020-0.022	0.021
DDT-Pp	0.026-0.028	0.027	0.079-9.985	0.087	0.024-0.026	0.025
Parathion methyl	0.051-0.053	0.052	0.0260.028	0.027	0.023-0.025	0.024
DDE-pp	0.007-0.009	0.008	0.004-0.006	0.005	0.003-0.005	0.074
Lindane	0.088-0.092	0.09	0.024-0.034	0.029	0.120-0.148	0.124
Dieldrin	00.082.078-	0.08	0.030-0.032	0.031	0.034-0.038	0.036
Heptachlor	0.049-0.051	0.05	0.036-0.042	0.039	0.020-0.024	0.002

Adapted from, Nyangababo 2005

Concentration of organochlorines generally decreased from simiyu through Katonga to Nyando indicating decreasing input of anthropogenic contaminants to the wetland ecosystem of Lake Victoria basin. At Katonga, relatively low levels of endosulfan alpha and endosulfan beta were observed which suggested a relatively minor use of these chemicals in agriculture in the nearby areas. In simiyu, very high concentrations of DDT and its metabolites were detected suggesting its historical use.

Pollution from Livestock production, China

Intensive production of livestock has also increased rapidly in the last 20 years and this has led to accumulation of huge amounts of organic waste [7]. Livestock and poultry farms produced 243 million tonnes of organic waste and 163 million tonnes of urine respectively in 2007[21].

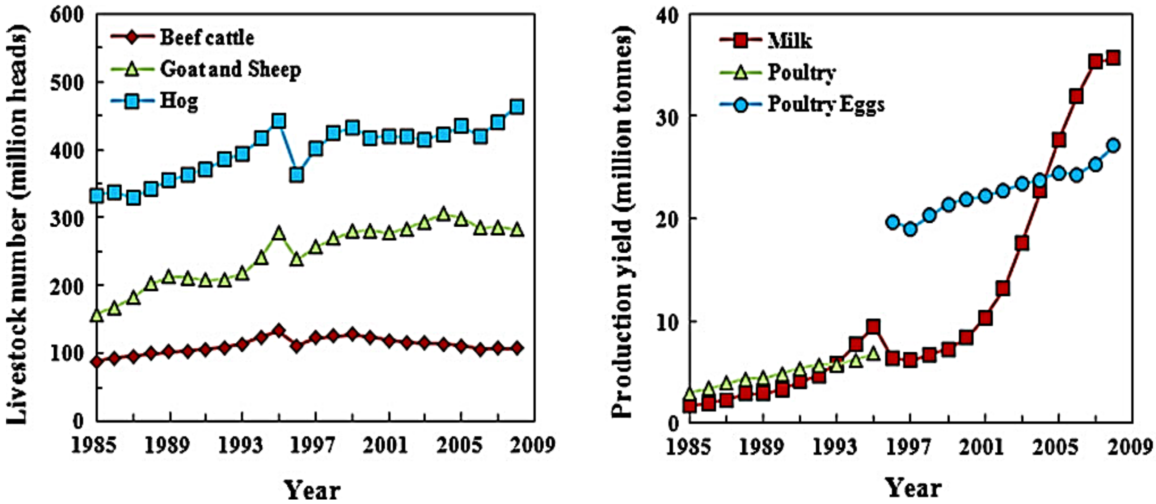

Fig 2: Livestock number and milk and poultry production in China from 1996 to 2008
Adapted from Sun 2012

In China, the proportion of animal wastes directly discharged to water was 2-8% for solid wastes and nearly 50% for liquid wastes in 2002 [5] The national average load of poultry manure in 2002 was 4.19 t ha^{-1} (based on the total cropland area), with the highest environmental risk of NPS pollution arising from this manure occurring in Shanghai, Henan, Tianjin and Shandong where the load [18 t ha^{-1} the medium level NPS risk was in Beijing, Jiangsu, Hebei, Anhui and Hunan where the average loads were between 5 and 18 t ha^{-1} [31].

Pollution from human excreta and domestic sewage systems

The N and P discharge in 2007 coming from human excreta of residents and livestock was larger than that from inorganic fertilizers application and has become the main cause of NPSP in China. This happened because the lack of national waste discharge standards has led to no or inadequate waste disposal or treatment facilities in 90% of the animal farms of China [1]. In China today, approximately 700 million people over half the population consume drinking water contaminated with levels of animal and human excreta that exceed maximum permissible levels by as much as 86% in rural areas and 28% in urban areas. By 2000, the volume of wastewater produced could double from 1990 levels to almost 78 billion tonnes. These are alarming trends with potentially serious consequences for human health.

New emerging pollutants

China is faced with a problem of a number of emerging organic pollutants. Emerging pollutants (EPs) are defined as synthetic or naturally occurring chemicals that are not commonly monitored in the environment but which have the potential to enter the environment and cause known or suspected adverse ecological and (or) human health effects [16] Occurrence of EPs can result from point (mainly urban and industry) or diffuse (agriculture) pollution. The transport of EPs from diffuse sources to the sink (water bodies) strongly depends on the EPs [11, 16] such as volatility, polarity, adsorption properties, persistence and the properties of the interacting compartments. Pollutants such as persistent organic pollutants (POPs) and endocrine disrupters (EDS) are increasingly found in sewage water, especially in urban wastewater treatment plants. Since there are only few advanced technologies for these pollutants in China, it has become a critical issue for water environment and ecological system management.

Some of the water bodies with high Non-point source pollution indices in China

Nearly all water bodies in China are affected by NPSP especially in the agricultural regions. The biggest challenge with non-point source pollution is the ability of the pollutant to move from places of high concentration to other places with the movement of water. In a long run, the places where such pollutants converge become more polluted than the source with various kinds of pollutants ranging from common pollutants of nitrogen and phosphorus to metal pollutants

Table 4: Water bodies that are affected heavily by Non-point source pollutants

Water body	Catchment size	Region	Population density	City(ies) in the region
Yangtze river	6300km^2	South Jiangsu province,	Urbanized and densely populated	Zhouzhuang, Yibin, Luzhou, Chongqing, Nanjing, Chengdu Fengdu, Wuhan, Taiz hou, Shanghai
Yellow river	5,464km^2	West	Urbanized and densely populated	Qinghai, Gansu, Ningxia, Linan, Jinan, Kaifeng, Zhengzhou
Haihe river	318000 km^2	North	Densely populated	Tianjin, Beijing
Heilongjiang River	4,370km ^{2}	North East	Densely populated	Heihe
Songhuajiang River	1,927km^2	Northeast	Densely populated	Harbin, Jiamusi, Yichun
Zhujiang River	2,200km^2	south	Densely populated	Guangzhou, Zhaoqing, Zhuhai, Macau
Brahmaputra	2,900 km	East to south	Over populated	Lhasa
Lancang River	2,354	Qinghai Province	Densely populated	Xishuangbanna
Nujiang River	2,816	Yunnan Province	6 million	Liuku, Bingzhongluo

Hanjiang River	1532 km	southwestern Shaanxi	Dense	Hanzhong, Ankang
Liaohe River	1,394	southern Northeast	Approximately 2 million people	Pingdingbao, Yingkou
The Pearl river	2,197	entrance of the South China Sea	Approximately 80 million people	Guangzhou, , Huizhou Shenzhen, Zhuhai, Dongguan, Zhongshan, Foshan, Jiangmen and Zhaoqing
Qinghai Lake	4,186 km^2	Qinhai, Northwest	Less dense	ZhiY, Baipaozi, Xingkaihu, Liumao
Xingkai Lake	4,190 km^2	Northeast	Approx 400,000	Muling, Jixi, Jidong, Mishan, Huling
Poyang Lake	3,210 km^2	Jiangxi	Moderate	Jiujiang
Taihu lake	2537km^2	Eastern	Urbanized, densely populated	Shanghai, Suzhou, Wux, Jiaxing, Huzhou, Changzhou
Hulun Lake	2339 km	Inner Mongolia	Sparse	Manzhouli,

Some of these rivers originate with in China and pour their water with in other water bodies in China. However, some of them pour their load in other countries of Asia like India and Bangladesh. Rivers flow carrying their load and other pollutants to different areas at different concentrations. For example, Yangtze River moves from Tanggula Mountain, it flows eastwards and pours itself into the East China Sea. It mainly runs across Qinghai-Tibet Plateau, Sichuan, Yunnan, Chongqing, Hubei, Hunan, Jiangxi, Anhui, Jiangsu and Shanghai from west to east running through different cities like Panzhihua, Yibin, Luzhou, Chongqing, Fengdu, Wuhan, Yichang,Jingzhou, Shashi, Shishou, Ezhou, Xianning, Huangshi, Huanggang,Yueyang, Hefei, Chaohu, Chizhou, Anqing, Tongling, Wuhu, Chuzhou, Maanshan, Jiujiang, Nanjing, Suzhou,Yangzhou, Zhenjiang, Jiangyin, Nantong, Taizhou, Shanghai. It carries pollutants from one area to another while picking other pollutants as it moves in other towns. In addition, these rivers have networks or tributaries bringing in water from other rivers and lakes and discharging water in different areas, rivers, lakes and oceans making it easier for non-point source pollutants to move across the entire region. This is because water especially from rivers move from arable lands in agricultural regions where fertilizers, pesticides and other chemicals are used. More so, there are also sewage discharged in the moving water in towns, rivers and streams also pass from heavily industrialized and polluted cities picking industrial and domestic wastes thereby transporting them across different places. Despite the presence of these water resources that are unevenly distributed both spatially and temporally (Cheng et al., 2009).

In general, China's issues on water resources particularly as regards pollution are intricate and challenging. Certainly this is because of a high population, spatial distribution of water resources that shows a general pattern of abundance in the South and scarce in the North with big disparity that is not in coincidence with the spatial distribution of land and mineral resources and productivity [4].

Land resources are abundant in the North where arable land accounts for 65% of nation's total with population accounting for 47% of China's total and GDP accounting for about 45% of country's total, but the share of water resource is only 19% of the total. In the South, water resource is abundant accounting for 81% of country's total, 53% of China's population inhabits, arable land and GDP accounts for 35% and 55% of China's total respectively. The per capita possession of water resource in the North is only one quarter of that in the South. Looking at river basins, most of the water resource in China is concentrated in the Yangtze River, Pearl River, and other river basins in the Southeast and Southwest, whereas the quantity of water resource in the Hai River, Yellow River, Huaihe River, Liaohe River, and Songhua River basins in the North and other river basins in the Northwest are quite small (Wang Shucheng, 2006; Xia Jun et al., 2008). In some areas in the North, the per capita possession of water resource is comparable with that of the most arid countries in the world. Even in the South rich in water resource, seasonal drought also happens frequently, resulting in difficulty in irrigating the irrigation dependent crops and some economic crops.

Since the founding of New China, the total amount of water use has been increasing year by year, but with little change since 1997. In general, the amount of agricultural water use shows an apparent fluctuation and a declining trend of its share in the total amount of water use, though still at 60%; the amount of industrial water use has been increasing slowly in recent years with its share in the total amount of water use being near to 25%; the amount of domestic water use has been increasing slowly and even more slowly since 2005 with its share of 12.2% in the total amount of water use. In 2007, the total amount of water supply in China was 581.9 billion m^3 accounting for 23% of the total amount of water resource in that year, of which 81.2% was from surface water resources, 18.4% from underground water, and 0.4% from other resources. Of the total water use in 2007 was 24.1% for industries, 61.9% for agriculture, 12.2% for domestic use, and 1.8% for ecological and environmental purposes (including, among others, urban environment water use through artificial facilities and water recharge for some rivers, lakes, and wetlands).To compare with 2006, the total amount of water use in 2007 increased by 2.4 billion m^3 , in that agricultural water use reduced by 6.6 billion m^3, industrial water use increased by 6 billion m^3, domestic water use increased by 1.7 billion m^3, and ecological and environmental recharge water increased by 1.3 billion m^3 [4]

In addition, the water use efficiency is comparatively low in China. The total amount of agricultural water use is huge, accounting for high percentage of the total amount of water use [4]Agricultural irrigation system is underdeveloped with irrational spatial distribution of water resource and low efficiency of irrigation water use which is only 25%-45%, whereas it is 70%-80% in developed countries. China's water resource productivity (GDP output per unit water use, yuan/m^3) is only one fifth of the world average, the average water resource productivity for grain crops is 1kg/m^3 in China and 2-2.5kg/m^3 in developed countries; the yield increase of grain crop by unit water is only one third of the world average; the amount of water use per ten thousand yuan of industrial output value is 5-10 times of that in developed countries (Xia Jun et al., 2008). The recycle rate of industrial water use is 40%, whereas it is 75%-85% in developed countries (2 & 6). Furthermore, the amount of industrial waste water discharge has been increasing and its treatment capacity and effectiveness need to be improved. The over-exploitation of water resource is closely linked to the water environmental pollution.

Water resource use of China's major rivers

Table 4: Water resource utilization of China's major rivers

River	Quantity of water resource(billion m^3)	Quantity of water supply(billion m^3)	Utilization rate %
Whole country	25 255.2	5 818.7	23.04
4 regions in the South	20 332.5	3 266.2	16.06
Six regions in the North	4 922.7	2 552.5	51.85
Songhua River	927.7	400.7	43.19
Liaohe River	381.9	204.3	53.50
Haihe River	247.8	385.1	155.41 (over-exploitation of groundwater
Yellow River	655.3	381.1	58.16
Huaihe River	1 365.9	554.4	40.59
Yangtze River	8 807.8	1 939.6	22.02
Rivers in the Southeast	1 799.8	338	18.78
Pearl River	3 985.9	879.9	22.08
Rivers in the Southwest	5 739.1	108.7	1.89
Rivers in the Northwest	1 343.9	626.9	46.65

Source: Ministry of Water Resource, P. R. China, 2008. China Water Resource Bulletin, 2007

At present, China is facing a severe water quality crisis caused by heavy water pollution. With its complicated resulting factors, wide scope and large amount, variety of pollutants, and high loading, China's water pollution issue has greatly worsened the situation of water shortage and threatened public health and living standard resulting in great socio-economic loss. In the agricultural production, the use of chemical fertilizer has been increasing year by year without having expected increase of grain yield, but resulting in increasingly heavy non-point source pollution and great impact on environmental quality.

In some areas, ground water pollution is getting more and more severe and water pollution incident occurs frequently (e.g. there were 482 water pollution incidents nationwide in 2006). The long term groundwater monitoring data from the Ministry of Land and Resources, the results of two rounds (1981-1984 and 2000-2002) of national groundwater resource assessment, and the outcome of groundwater pollution survey conducted in some areas since 1999 showed that the groundwater in large and medium-sized cities has been polluted to different extent with heavy pollution occurred in the built-up area of about half of the cities; the groundwater quality in most of the cities showed the trend of degradation so that the shallow layer groundwater could not be drunk directly in some cities; in the major metropolitan areas of Beijing-Tianjin-Hebei, Yangtze River delta, and Pearl River delta, trace amount of toxic organic pollutants had been detected, in that the highest detected value of Dibutyl phthalate was 1.4 times higher than that provided for by the national drinking water standard, and the highest detected value of Di(2-ethylhexyl)phthalate was 0.125 times higher than that provided for by the national drinking water standard.

The drinking water safety has been a big issue in China. The rural population without safe drinking water has reached to 323 million. From 1978 to 1987, the area of lake eutrophication has increased from 5% to 55.1%; after 1990s, the issue had become more severe, especially in Dianchi lake, Taihu lake, and Chaohu lake-the three fresh water lakes where the eutrophication has been most serious and the water quality declined from class III (the lowest class for drinking water source) to class V; from 2001 to 2005, the annual growth rate of China's industry was 8%-18%. Meanwhile, the area of water bodies of class V had increased 3%-5% annually, equivalent to turning 3000km^2 of lake water from class III to class V per 10% industrial growth. The functions of the water bodies have lost partially or at all due to the continued overall degradation of water resource. 33% of the functional water bodies have received more pollutants than their environmental carrying capacity only because of the point source discharge. Only 56% of the water function zones in the country can meet the standard. The water quality of water function zones in Hai River, Huaihe River, Songhua River, and Liaohe River was much worse than the targeted requirements, with the meet-the standard rate less than 40% [3]

Policy on non-point source pollution, fertilizer; China and Uganda

China has had a number of environmental pollution policies for the last 30 years and has invested a great deal of resources to control pollution for a long time [17]. Between 1996 and 2005, China implemented the ''Trans-Century Green Project Plan''. The key regions were three rivers (Huai River, Hai River, and Liao River), three lakes (Taihu, Chaohu, & Dianchi) and two zones (SO2 Pollution Control Zone and Acid Rain Control Zone), one city (Beijing), one sea (Bohai), the Three Gorge Reservoir and upper reaches of the Yangtze river and the area of the project on water conveyed from South to North [17] Since the 1980s, environmental legislation in China has been enhanced year after year, and now there is a Water science and Technology roadmap 2050 to prioritize future strategic priorities of China to attain sustainable development. There have been laws and policies that have been promulgated to protect water bodies from being mismanaged and polluted but there is need for government commitment at all levels, Central and Local governments to specifically prioritize NPSP. It is however necessary to involve all key stakeholders like rural farmers, town dwellers and recruit extension officers to teach communities, the dangers associated with the problem.

Uganda still faces a challenge on water and fertilizer policies. There is currently no policy on fertilizer use in agriculture. The fertilizer market is dominated by small scale traders, high prices and low market margins [29]. This therefore makes fertilizer use difficult. There has been and there is still no sign of fertilizer development for decades. The total fertilizer consumption (Nitrogenous fertilizers) remain at a low level, the 5-year average in Uganda is only 3842 tons [9].

CONCLUSIONS AND RECOMMENDATIONS

To sum up, in the last 20 years, China's water pollution problems have rapidly increased in both small rivers and bigger ones, from surface to groundwater, jeopardizing the sustainable use of water resource; water pollution and water body eutrophication, algae and bacteria in water bodies threaten the safety of drinking water. It is therefore important for China to develop a very good policy on non-point source pollution in addition to existing water policies to tackle this increasing disaster.

As for Uganda, NPSP is not yet a very big problem despite the presence of pollutants like copper, zinc, chromium and others that were majorly from copper and cobalt mining areas in Kilembe, Kasese District in 1970's and 1980's . They are still at low level within acceptable ranges, but with population increasing, soil fertility reduction and with the demand to increase food production to combat hunger, fertilizer use will be the way to go in the near future. Therefore, Uganda has to learn lessons from China so that bad agricultural practices are avoided and only good agricultural practices practiced to promote sound, sustainable, ecological management practices while maintaining the quality of water, soil and air. Development can be achieved while taking care of natural resources through proper planning and policy formulations with clear implementation strategies.

Since Non-point source point pollution is greatly caused by fertilisers as a result of the run off from agricultural field, there is need to find out the ideal quantity of fertiliser to be applied, the climatic conditions and the slope of the land. For example, the fertiliser will find its way to the water body even if the right amount was applied and other good agricultural practices practiced. This is especially common with erratic climatic changes that are characterised by storms and floods. It is therefore important to integrate all approaches and tools like Geographical information systems (GIS), weather forecasts and hydrological modeling techniques so as to reduce fertiliser movement in water. This, of course is possible if the governments support both small scale and commercial farmers, in terms of skills development and research enhancement.

It worth noting that remediating a spoilt environment (water, air, soil, forest, swamp) can be an expensive venture for any country irrespective of its level of economic development and can take very many decades.

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