Urbanization and Demand for Water and Sanitation Services: An Analysis on Cross-Region Investment Requirements

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Abstract

With advent of economic growth, rapid urbanization has led to a consequent rise in demand for water supply and sanitation (WSS) services. The growth rate of urban population is quite high in regions characterized by low and middle-income, namely, Sub-Saharan Africa, South Asia, Middle East and North Africa, East Asia and the Pacific, Latin America and the Caribbean. Given the poor access to WSS across several regions, the present analysis attempts to estimate the demand for investment in this sector. The empirical estimates reveals that to achieve universal access to improved WSS by 2019, the stock of investment in water services should reach US $2,240 billion at 2005 prices in 2019. At the given stock of investment in 2012, an additional investment of US$ 590 billion (US$ 134 billion in water supply and US$ 456 billion in sanitation) would be required in new water services infrastructure to reach the desired stock of investment by 2019. Given the high investment requirements in lower-income countries, and the potential shortfall in required capacity creation through government budgetary devolutions, the analysis recommends move towards several reforms, including, liberalization of investment regimes, implementation of water-saving innovations, integration of stormwater and rainwater management practices with the wider urban planning.

Keyword: water and sanitation service, infrastructure investment, MDG, urbanization

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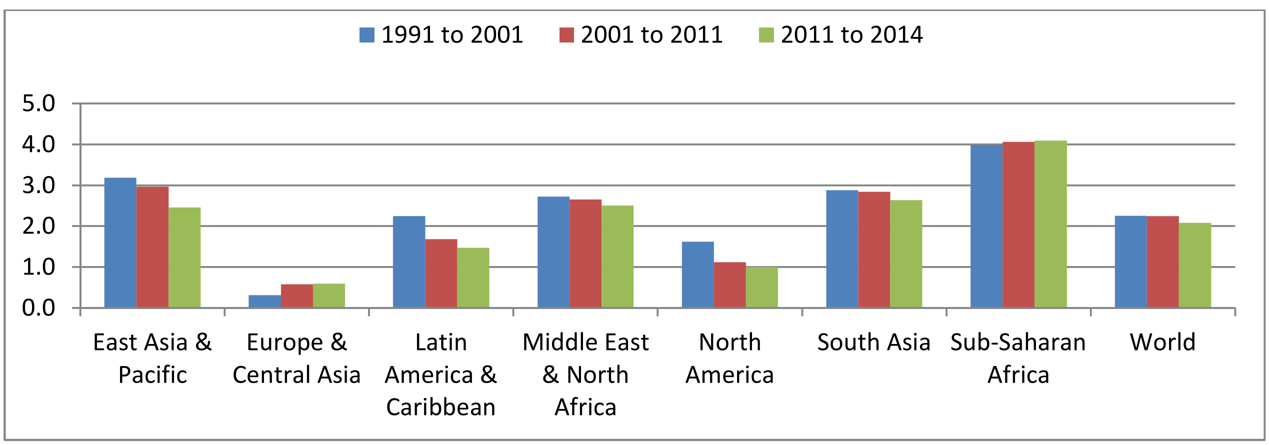
1. Introduction

With advent of economic growth, the world is witnessing a rise in urbanization and a consequent growth in demand for services to cater to the evolving scenario. With half of the world population staying in the cities, the demand for key services like safe drinking water and sanitation is likely to emerge as a major challenge in coming days (Cohen, 2006). Van der Bruggen et al. (2010) have explained the water supply problems in urbanized regions of the developing countries as the interaction of three interrelated factors, namely: (1) high population growth, (2) lower than required investments in water supply infrastructure, and (3) availability of water sources. Mukherjee et al. (2010) observed that due to rapid population growth, urbanization and industrialization, water supplies from local water resources are falling far short of the high and concentrated demands in most urban areas.

The extent of the rise in urban population across the regions can be observed from Figure 1, which displays region-wise annual exponential growth rate of the urban population in percentage terms. To get a temporal perspective, the period over 1991-2014 has been divided in three periods. It is observed that the growth rate in urban population is maximum in case of Sub-Saharan Africa, followed by South Asia, Middle East and North Africa, East Asia and the Pacific and Latin America and the Caribbean. Interestingly, barring the exception of Sub-Saharan Africa, the urban population growth rate in all other regions are on the decline.

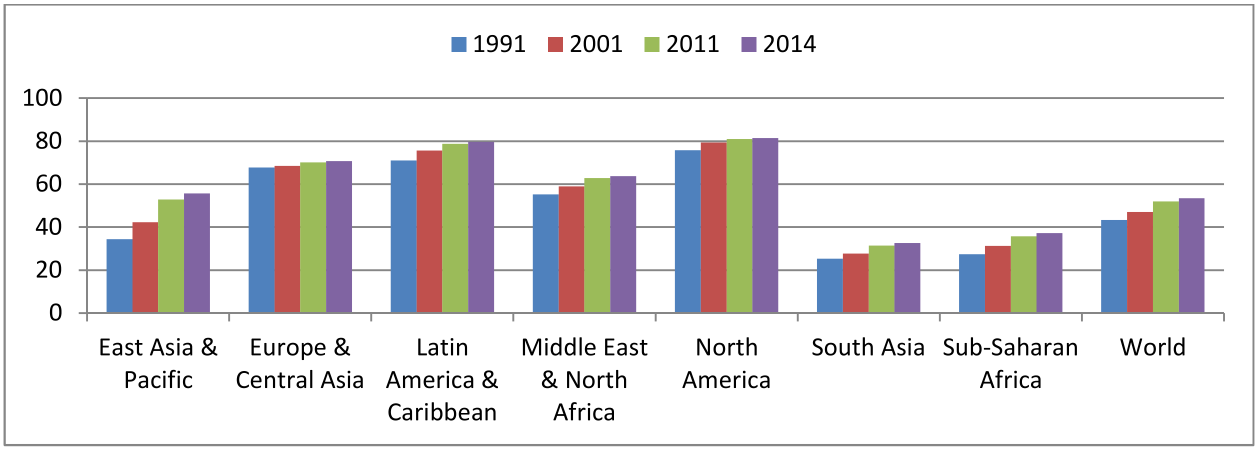
Figure 2 compares the region-wise urban population scenario, by expressing the same as percentage of total population for 1991, 2001, 2011 and 2014. The figure shows that rising urban population is not simply a developed country (North America, Europe and Central Asia) phenomenon, which is similarly evident in the developing country regions (Latin America and the Caribbean, followed by Middle East and North Africa, East Asia and the Pacific, Sub-Saharan Africa, South Asia) as well.

Figure 1: Region-wise Annual Exponential Growth Rate of Urban Population (%)



Source: Constructed by authors from World Development Indicator database

Figure 2: Region-wise Urban Population as Percentage of Total Population



Source: Constructed by authors from World Development Indicator database

The evolving challenges have been recognized both in Target 7.C of the Millennium Development Goals (MDGs), which aims to, 'halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation' (UN undated a); and Goal 6 of the Sustainable Development Goals (SDGs), which attempts to, 'Ensure availability and sustainable management of water and sanitation for all' (UN undated b). However in 2012, 748 million people, mostly from the lower and middle-income countries, had to rely on unsafe drinking water sources (UN-Water and WHO, 2014: 15). In 2012, around 2.5 billion people still lacked improved sanitation facilities, while around 1 billion people had to defecate openly (World Bank, 2014: 2). Ensuring improved sanitation facilities is crucial for securing safe drinking water. Better access to water supply and sanitation (WSS) are in turn basic building blocks to improve health and nutrition status of people (Cronin *et al*., 2015: 229).

The present analysis attempts to estimate the demand for investment in WSS, and is arranged in the following manner. The next section briefly reviews the methodological issues on estimation of the demand for investment in water services infrastructure, followed by the current scenario. The present stock and projected demand of investment in WSS infrastructure is estimated in the following section. Finally, based on the findings, the policy conclusions are drawn.

2. Literature review on estimation of demand for investment in water services infrastructure

The mainstream literature on estimation of investment demand for infrastructure often uses parametric estimation and projections based on regression models, as developed by Fay and Yepes (2003: 3-5). For projecting the demand for investment in water services infrastructure, World Health Organisation (WHO) however follows a different methodology.

The analysis of Fay and Yepes (2003) established econometric relationship between access to WSS (present stock of investment in water services infrastructure) with per capita income, structural composition of the economy (share of agriculture and manufacturing in GDP), population density and level of urbanization. Based on the estimated relationship, the study projected the demand for access to WSS on the projected values of the independent variables for 2010. While Fay and Yepes (2003) estimated annual investment requirements during 2005-10 across regions (presented in Table 1), their underlying methodology did not take the achievement target for universal access to WSS into consideration. On the contrary, the methodology implicitly assumed that the status quo in access to WSS would continue with future demand for investments come from set of independent variables, given the stock of present investment. Since the methodology does not set achievement targets for access to WSS, the projected figures of the same is likely to cross the maximum achievable target of 100 %. The problem cannot be solved even through application of sophisticated econometric estimation techniques, e.g., censored panel regression model. Therefore, there is sufficient reason to believe that the estimates based on this methodology is prone to over-estimate the demand for investment. However, the methodology is useful to estimate demand for investment in other infrastructure sectors (e.g. road transport) and also for water services other than for domestic purposes.

Table 1 reveals that an annual investment of US$ 22.112 million and US$ 31.148 million is required in water supply and sanitation respectively during 2005-10. It deserves mention that this analysis considers only 3 % of the replacement cost of the capital stock as maintenance requirement for water services, which is actually the minimum annual average expenditure, below which the network's functionality will be threatened (Fay and Yepes, 2003: 10). It is observed that this replacement cost figure is quite low in comparison with the corresponding number considered in other similar studies (WHO 2012: 54-55, Hutton and Bartram 2008: 14).

Table 1: Expected Annual Investment needs (2005-2010) on Water and Sanitation, $ million and Percentage of GDP (all prices in constant 1995 US$)

Countries	Water				Sanitation			
	New		Maintenance		New		Maintenance	
East Asia & Pacific	1,799	(0.07)	3,602	(0.13)	2,608	(0.1)	4,202	(0.15)
South Asia	1,912	(0.21)	3,286	(0.36)	1,707	(0.19)	2,417	(0.26)
Europe & Central Asia	235	(0.02)	1,436	(0.1)	750	(0.05)	2,616	(0.18)
Middle East and North Africa	399	(0.06)	629	(0.1)	691	(0.11)	1,030	(0.16)
Sub-Saharan Africa	689	(0.15)	949	(0.2)	1,256	(0.27)	1,619	(0.35)
Latin America & Caribbean	645	(0.03)	1,245	(0.05)	1,147	(0.05)	1,989	(0.08)
High Income	565	(0)	4,719	(0.01)	982	(0)	8,133	(0.02)
Low Income	2,974	(0.19)	5,036	(0.32)	3,706	(0.24)	5,462	(0.35)
Middle Income	2,707	(0.04)	6,111	(0.09)	4,454	(0.06)	8,410	(0.12)
Developing Regions	5,681	(0.07)	11,147	(0.13)	8,160	(0.1)	13,872	(0.16)
WORLD	6,246	(0.02)	15,866	(0.04)	9,143	(0.02)	22,005	(0.05)

Note: Figures in the parenthesis show the percentage of GDP
Source: Fay and Yepes (2003)

A series of subsequent studies have followed the Fay and Yepes (2003) methodology. For instance, Bhattacharyay (2010: 13) have estimated the demand for water services infrastructure investment in Asia and the Pacific during 2010-20, which stands at US$ 280.24 billion (Table 2). Of this estimated demand for investment, US$ 113.22 billion and US$ 167.02 billion are originating from water supply and sanitation respectively, which on average represents 0.22 % of GDP of the region. Bhattacharya *et al*. (2012: 13) have estimated that the annual investment requirements for water supply in the developing world would range over 15-30% of total annual investment required in infrastructure of US$1.8 – 2.3 trillion (in 2008 constant prices).

Table 2: Sub-region wise Investment Needs in Water Services Infrastructure in Asia, 2010-2020 (2008 US$ billions)

Region	Water	Sanitation	Water and Sanitation	
			2008 US$ Billion	% of GDP
East and Southeast Asia	58.37	112.88	171.25	0.17
South Asia	46.12	38.97	85.09	0.39
Central Asia	8.6	14.8	23.4	0.42
The Pacific	0.14	0.36	0.51	0.30
Total	113.22	167.02	280.24	0.22

Source: Bhattacharyay (2010: 13)

While there exist a sizable literature on estimates of demand for investment in water supply infrastructure, none of them are free from criticisms. The current analysis presents some of the critical issues involved in estimation of global demand for investment in WSS in the following:

a) *Per Unit Cost of Water Supply and Sanitation*: There is no standard estimate on cost of supplying safe drinking WSS for each household, which ideally represents the actual cost of providing these services across continents and income groups. Moreover, as evident from the literature (e.g., Fay and Yepes, 2003), the available estimates do not specify the technology and makes no distinction between the possible costs prevailing in rural and urban belts in their analysis. Often the information on access to WSS is provided in terms of percentage of population, whereas in reality, the cost estimates are generated for per household. It is widely known that the household size varies not only across countries but also across location of residence (rural and urban) within countries. Therefore, any assumption on household size may not always reflect actual reality and the estimated demand for investment could be either under-estimated or over-estimated, depending on the assumption on average household size.

b) *Supply versus Demand for Water*: Ironically, most of the estimates on demand for investment in water services do not consider availability of water in their models. This separation of demand and supply forces in the analysis could pose a serious limitation to the cost estimates, as the incremental costs of water supply (both resource and environmental costs) are not taken into account in such models (Kumar, 2012: 165). Access to safe sanitation cannot logically be de-linked from access to water supplies. Hence, the demand estimates for investment in sanitation services should take into account not only the cost of augmenting water supply but also cost of water and sewage treatment as well (including sewerage disposal).

c) *Projection of Variables*: There are several development-related factors, on which the demand for investment in water services in a country is heavily dependent on (e.g., per capita income, structural composition of the economy, state of technology adoption, population density, urbanization. level of human development). However, obtaining a realistic long time-series projection of all these variables, so as to correctly estimate the demand for a specific future date, is an area of major concern.

d) *Operation and Maintenance Costs*: In addition to the capital investment requirement in new projects, the costs of maintaining existing projects (e.g., replacement and repairing expenses), and running expenditure for the new and old projects is equally important. In addition, the cost of maintenance depends on several factors, namely - vintages of stock of investment / projects, state of technologies, source of water supply, regulatory standard for drinking water etc. Depending on the relative importance of these factors, cost of operation and maintenance of WSS projects varies widely across countries. It deserves mention that unlike sanitation services, where most of the operation and maintenance (O&M) cost is borne by the beneficiaries, responsibility of operating and maintaining water supply projects lies with the community and / or water supply authorities.

Offering an alternative methodology, WHO (2012: 7) estimates the total financial capital costs to expand coverage to achieve universal access of improved drinking-water sources and sanitation during 2010-15 in constant 2010 prices of US$ billion (Table 3). The estimate reveals that to achieve universal access in water supply across all the regions, an investment of US$ 203.3 billion is required during 2010-15. To achieve universal access in sanitation services, an investment of US$ 332.4 billion is required over the same period. In contrast to the Fay and Yepes (2003) methodology, the WHO (2012) study has been based on population projection of 2015 and unit cost of providing access to safe drinking water and sanitation. One distinct edge of this analysis over the Fay and Yepes (2003) study is that the region-wise investment requirement has been presented here separately for rural and urban areas. However, this methodology does not consider other demand for water services (other than domestic demand).

Table 3: Total financial capital costs to expand coverage to achieve universal access of improved drinking-water sources and sanitation, from 2010-2015 (2010 US$ billions)

	Water supply			Sanitation		
Region	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**
Caucasus and Central Asia (CCA)	2.0	1.8	3.8	2.7	0.8	3.6
North Africa	8.8	3.1	11.9	5.0	1.3	6.4
Sub-Saharan Africa (SSA)	13.6	16.0	29.6	47.0	48.2	95.2
Latin America and the Caribbean (LAC)	24.7	4.4	29.1	29.1	10.2	39.3
East Asia	48.9	21.3	70.2	50.8	16.6	67.4
South Asia	4.2	3.6	7.8	43.7	45.5	89.2
Southeast Asia	22.8	6.7	29.5	8.3	7.6	15.9
West Asia	15.7	4.6	20.4	11.0	3.8	14.8
Oceania	0.2	0.7	0.9	0.2	0.5	0.7
All	141.0	62.3	203.3	197.9	134.5	332.4

Source: WHO (2012)

Following the WHO (2012) methodology of unit cost, Hutton and Bartram (2008: 9) estimates sub-region wise cost of providing water and sanitation coverage to meet MDG target. It is observed that an estimated amount of US $ 363.5 billion is required to achieve water supply coverage goal of MDGs, while an investment of US $ 357.5 billion is required for fulfilling the access to sanitation related objective. The study further noted that a major proportion of the estimated investment is required on provision of urban water supply (68 %) and urban sanitation facilities (59 %). Lloyd-Owen (2009) estimates region-wise cost of capital and operating costs water and wastewater for 67 countries, showing that the capital spending requirement would reach US$ 2.9 trillion, while the operating cost would be US$6.8 trillion during the period 2010-29 (OECD, 2011: 43).

Given the constraints in estimating global demand for investment in water services infrastructure, there are two alternative methods - bottom-up approach and top-down approach. On one hand, the main objective of global approach (top-down approach) is to highlight the projected demand for investment at a macro level to initiate dialogue for mobilizing the necessary finances for investment. Conversely, the importance of project level estimation (bottom-up approach) of demand for investment is concerned more with facilitating financial planning for execution of investment in efficient manner.

3 Estimation of demand for investment in water services infrastructure

3.1 Present state of water and sanitation services

Before analyzing the investment requirement for WSS services, the evolving pattern of access to improved water source and sanitation facilities over the last two decades is discussed in this sub-section with the help of World Development Indicators data. Table 4 demonstrates that access to improved water source is still lacking in Sub-Saharan Africa (SSA) and South Asia (SA). People's access to improved water sources has increased by more than 4 % in every 5 year in SSA region since 1990 and for South Asia the corresponding figure was more than 5 %. As compared to the scenario on water supply, access to improved sanitation facilities is still lacking substantially for SSA, SA, East Asia and Pacific (EAP) and Latin America and Caribbean (LAC). In case of access to sanitation services, substantial improvement for the SA region is noticed (i.e., more than 5 % in every five year since 2001). On the other hand, the improvement in access to sanitation for SSA has been considerably slower, particularly in the post-2005 period. In comparison with these regions, the performance of countries located in Europe & Central Asia (ECA), Middle East & North Africa (MENA) and North America (NA) have been far superior.

Table 4: Region-wise Average Access to improved water source and sanitation (rural and urban combined)

Regions	Improved water source (% of population with access)					Improved sanitation facilities (% of population with access)				
	1990-95	1996-2000	2001-05	2006-10	2011-12	1990-95	1996-2000	2001-05	2006-10	2011-12
East Asia & Pacific (EAP)	80.8	82.0	85.0	87.9	89.5	61.7	63.1	66.4	70.3	72.4
Europe & Central Asia (ECA)	95.5	95.5	96.1	96.6	97.0	95.4	94.4	94.9	95.9	96.9
Latin America & Caribbean (LAC)	85.8	88.4	90.3	92.0	93.0	70.7	75.1	77.9	79.6	80.9
Middle East & North Africa (MENA)	88.4	89.1	91.0	91.8	92.4	83.7	86.3	88.6	90.2	91.1
North America (NA)	99.2	99.3	99.4	99.4	99.5	99.7	99.8	99.8	99.9	99.9
South Asia (SA)	68.2	73.2	78.9	84.6	88.4	36.7	41.2	46.3	51.8	55.2
Sub-Saharan Africa (SSA)	56.4	60.7	64.7	68.9	71.7	26.9	29.2	31.2	32.6	34.1

Source: Computed by authors based on World Bank (undated a)

For analyzing the scenario at a more disaggregated level, disparity in access to improved water sources between rural and urban areas over the last two decades across the regions has been compared in Table 5. Though the disparity was very high for EAP, LAC and SA regions during 1990s, the same has gone down substantially over the years. However for the SSA region, despite improvements in the rural belt, a similar decline in rural and urban disparity in access to improved water sources has not been observed yet.

Table 5: Region-wise average access to improved water source in rural and urban areas

Regions	Improved water source, rural (% of rural population with access)					Improved water source, urban (% of urban population with access)				
	1990-95	1996-2000	2001-05	2006-10	2011-12	1990-95	1996-2000	2001-05	2006-10	2011-12
EAP	75.0	76.7	80.3	83.8	85.7	91.5	91.7	93.4	95.0	96.1
ECA	92.2	92.3	93.5	94.5	95.3	98.7	98.9	99.0	99.0	99.0
LAC	73.9	78.1	81.1	84.4	86.8	94.1	94.8	95.4	95.9	96.2
MENA	81.2	82.4	84.8	86.3	87.2	94.0	93.9	95.2	95.3	95.5
NA	96.7	97.2	97.7	98.1	98.5	99.9	99.8	99.8	99.7	99.7
SA	63.1	69.9	75.9	82.1	86.4	85.1	85.7	88.9	92.0	94.2
SSA	47.3	50.7	54.5	58.7	62.1	80.6	81.7	84.0	86.6	88.4

Source: Computed by authors based on World Bank (undated a)

The cross-region scenario for rural-urban disparity in improved sanitation services has been presented in Table 6. Unlike in access to water supply, the disparity in access to improved sanitation is not declining for EAP and SSA regions. On the other hand, the pace of the corresponding decline in other low and middle income countries located in LAC, MENA and SA regions is found to be quite slow.

Table 6: Region-wise average access to improved sanitation in rural and urban areas

Regions	Improved sanitation facilities, rural (% of rural population with access)					Improved sanitation facilities, urban (% of urban population with access)				
	1990-95	1996-2000	2001-05	2006-10	2011-12	1990-95	1996-2000	2001-05	2006-10	2011-12
EAP	56.0	56.8	60.2	64.5	66.5	73.4	75.0	78.4	81.5	83.3
ECA	92.8	91.5	92.3	93.8	95.2	97.4	96.7	96.9	97.4	97.9
LAC	57.8	64.0	67.7	70.0	71.6	79.3	81.4	83.1	84.3	85.3
MENA	73.8	77.2	80.9	84.0	85.4	92.2	93.1	94.2	95.0	95.3
NA	98.9	99.1	99.2	99.4	99.5	99.9	99.9	100.0	100.0	100.0
SA	29.5	34.4	39.8	45.7	49.4	59.2	60.9	63.1	65.6	67.3
SSA	19.9	22.3	23.8	24.3	25.2	41.6	42.6	44.0	44.7	45.2

Source: Computed by authors based on World Bank (undated a)

From the analysis so far, it is evident that majority of future investment for improving access to water supply is required in SSA, SA and EAP regions. It is observed from Table 7 that as on 2012, there are around 750 million populations lack access to improved sources of water, while 2.10 billion people do not have access to improved sanitation facilities. The majority of these people live in SSA, EAP and SA regions. In SA alone 730 million people do not have access to improved sanitation facilities. Therefore providing access to improved WSS services to such a sizable chunk of population living in lower and middle income countries would be a major challenge.

Table 7: Region-wise Population without access to Improved Source of Water and Sanitation (2012)

Regions	Average Access to Improved Water Source (% of Population)	Average Access to Improved Sanitation (% of Population)	Total Population (Billion)	Population Without Access to Improved Water Source (Billion Population)	Population Without Access to Improved Sanitation (Billion Population)
EAP	89.62	72.64	2.20	0.23	0.60
ECA	97.08	96.94	0.75	0.02	0.02
LAC	93.11	81.19	0.60	0.04	0.11
MENA	92.43	91.19	0.40	0.03	0.03
NA	99.50	99.90	0.35	0.00	0.00
SA	88.95	55.53	1.65	0.18	0.73
SSA	72.51	34.41	0.90	0.25	0.59
Total			6.85	0.75	2.10

Source: Computed by authors based on World Bank (undated a)

3.2 Current Stock of Investment in Water Services Infrastructure

The estimation of present stock of investment to provide improved WSS across regions is important for this analysis primarily for two reasons. First, the costs of operation and maintenance of water supply infrastructure (inclusive of both Water Supply and Sanitation services) not only depend on future investment but also on present stock of investment. Second, the estimation of stock of investment not only depends on the percentage of population having access to WSS, but also on several ground-level base factors, e.g., size of population of the regions, average family size, and choice of technology.

The estimation of present stock of investment is contingent upon two key factors. First, the unit cost of providing access to improved WSS generally varies across countries, depending on their regulatory standard for supply water quality, source(s) adjusted quality of raw water, level of treatment requirements (and choice of technology thereof), distribution system, and population density. In most of the cases the unit cost figures are presented in per household level, whereas the data on access to WSS is available as percentage of population. Variations across regions in estimates of per unit cost prevailing in their territories are presented in Table 8 (Toubkiss, 2006: 29-30). Second, there exist wide variations in average family size across regions and countries and even across locations (i.e., rural – urban) within a country, which also influence the estimation of demand for investment in WSS.

Table 8: Unit costs of water and sanitation improvements, excluding programme costs

Improvement type	Per capita (US$ year 2005*)					
	Initial investment costs			Annual recurrent cost		
	Africa	Asia	LAC	Africa	Asia	LAC
Water improvement						
Household connection (treated)	164	148	232	13.4	9.6	14.6
Standpost	50	103	66	0.5	1.0	0.7
Borehole	37	27	89	0.2	0.2	0.6
Dug well	34	35	77	0.2	0.2	0.5
Rainwater	79	55	58	0.5	0.4	0.4
Average of non-household connection options	50	55	72	0.4	0.5	0.5
Sanitation improvement						
Household connection (partial treatment)	193	248	258	8.2	9.1	11.0
Septic tank	185	167	258	6.2	6.1	6.8
Pour-flush	147	81	97	6.1	5.5	5.7
VIP	92	81	84	3.8	3.8	3.8
Simple pit latrine	63	42	97	3.6	3.5	3.9
Average of non-household connection options	122	93	134	4.9	4.7	5.0

Notes: * Data from 2000 adjusted to 2005 prices using an average annual gross domestic product (GDP) deflator of 10%
Source: Adjusted by authors on estimation by Toubkiss (2006)

One serious criticism against the unit costs estimated by Toubkiss (2006) is that it does not provide estimates for all the sub-regions that are in dire need for investment in this sphere separately (e.g., South Asia and Sub-Saharan Africa). The present analysis has relied on per unit cost estimates as provided by Fay and Yepes (2003), where data on sub-regions are obtained separately.

The estimation process of the current analysis is first explained with the help of Table 9. The data on region-wise distribution of population with access to improved WSS services has been estimated on the basis of figures obtained from UN-Water and WHO (2014). From Worldmapper (undated), the figures on average household sizes across regions are taken. By dividing the former series by the latter, the present analysis arrives at the number of average households (in billions) per region with access to improved water and sanitation facilities separately.

Table 9: Household Scenario in Water Supply and Sanitation - 2012

Regions	Population with access (in billion)		Average Household Size[(a)]	Households with access (in billion)	
	Improved Water Source	Improved Sanitation		Improved Water Source	Improved Sanitation
EAP	1.97	1.60	4.3	0.45	0.37
ECA	0.73	0.73	2.9	0.25	0.25
LAC	0.56	0.49	5.0	0.11	0.10
MENA	0.37	0.36	4.3	0.08	0.08
NA	0.35	0.35	2.9	0.12	0.12
SA	1.47	0.92	5.6	0.26	0.16
SSA	0.65	0.31	4.9	0.13	0.06
Total	**6.10**	**4.75**		**1.42**	**1.15**

Note: (a) obtained from Worldmapper (undated)
Source: Computed by the authors based on World Bank (undated a)

The estimation results of the current analysis are presented in Table 10. If unit cost of providing water services are considered in line with Fay and Yepes (2003), (those are US$ 400 per household for water supply and US$ 700 per household for sanitation at 2000 prices) and taken at 2005 prices by using region-wise GDP deflator, the estimated stock of investment in water services for 1.42 billion households having access to improved water source comes out to be US$ 680 billion (at 2005 prices). On the other hand, the estimated stock of investment for 1.15 billion households having access to improved sanitation would reach US$ 969 billion (at 2005 prices). It is observed from Table 10 that the majority of these investments needs to be incurred in EAP, ECA and SA.

Table 10: Region-wise Stock of Investment in Water Services Infrastructure - 2012 (at 2005 Prices, US$ Billion)

Regions	**Water Supply**		**Sanitation**	
EAP	188	(27.7)	267	(27.6)
ECA	147	(21.6)	257	(26.5)
LAC	51	(7.5)	78	(8.1)
MENA	43	(6.4)	75	(7.7)
NA	54	(7.9)	95	(9.8)
SA	127	(18.7)	139	(14.3)
SSA	69	(10.2)	58	(5.9)
Total	680	(100)	969	(100)

Note: Figure in the parenthesis show the percentage share in total investment
Source: Computed by the authors

3.3 Future Stock of Investment in Water Services Infrastructure

To estimate future demand for investment in water services infrastructure, there is a need to consider several factors, e.g., the evolving nature of the population, the inter-sectoral dynamics, costs associated with additional investment to cope with climate change related concerns, growing income, actual per unit cost of WSS services depending on family size, sustainability perspective of providing universal access to WSS services etc. Based on World Bank population projection for 2019 (World Bank, undated b), and given the average size of the household (region-wise) available from Worldmapper (undated), the present analysis assumes status quo of household size will persist and estimates the number of households for the year 2019. The estimates are summarized in Table 11. It is observed from the table that the total estimated number of households comes to 1.70 billion.

Table 11: Region-wise Projection of Households

Regions	Total Population: 2019	Average Household Size[a]	No. of Households: 2019
EAP	2.30	4.35	0.53
ECA	0.77	2.90	0.26
LAC	0.65	5.00	0.13
MENA	0.45	4.35	0.10
NA	0.37	2.94	0.13
SA	1.80	5.56	0.32
SSA	1.08	4.88	0.22
Total	7.41		1.70

Source: (a) obtained from Worldmapper (undated)
Source: Computed by the authors

The demand for investment in water service infrastructure by 2019, as estimated by the current analysis, has been presented in Table 12. It is observed that if all the households are provided with improved source of water and sanitation (i.e., universal access) by 2019, the total stock of investment in water services infrastructure would reach US $2,240 billion at 2005 prices by 2019. Looking at the sectoral distribution, the stock of investment in infrastructure should reach US$ 814 billion and US$ 1,425 billion for water supply and sanitation respectively. Therefore, given the stock of investment in 2012, an additional (capital) investment of US$ 590 billion is required during 2013-19 in new water services infrastructure to reach the desired stock of investment in 2019. The additional expenditure of US$ 134 billion would be required in the area of water supply, while the residual US$ 456 billion needs to be spent in sanitation sector.

If the capital investment requirement is spread out equally over the entire period of planning (i.e., 2013-19), an equal annual investment of US$ 19 billion in water supply and US$ 65 billion in sanitation are required to achieve the universal access to improved WSS by 2019. However, to protect the value of present of stock of investment and to keep it functional, it requires repairs, replacement etc.

Hutton and Bartram (2008: 7) noted that, '[A]nnual operation and maintenance (O & M) costs 5–10% of capital cost for low-technology options, water source protection an additional 5–10% of capital cost per year, and education for sanitation interventions 5% of capital cost per year.' In line with Hutton and Bartram (2008), the present analysis assumes that the cost of repair and replacement would be 15 percent of present value (stock) of investment during 2013-19. This cost also includes repair and replacement cost of future investment which will be carried out during

2013-19. Therefore, in addition to new investment for infrastructure, additional investment of US$ 247 billion is required for repair and replacement, the region-wise distribution of which is also summarized in Table 12. Therefore taking both the capital investment and repair and replacement components into consideration, the total annual investment in water services infrastructure required during 2013-19 comes out as US$ 332 billion, of which the annual capital cost and annual O&M costs are of US$ 84.3 billion and US$ 247.4 billion respectively.

Table 12: Projection of Demand for Investment in Water Services Infrastructure by 2019 (in US$ Billion, 2005 Prices)

Regions	Capital Expenses						O&M		Total		
	Stock of Investment Required in 2019 (A)		Additional Investment Required by 2019 (B)		Additional Annual Investment Required during 2013-2019 (C)=(B/7)		Repair, Replacement and Operation Cost (D)		Annual Investment Required during 2013-2019 (E)=(C+D)		
	Water Supply	Sanitation	Water Supply	Sanitation	Water	Sanitation	Water Supply	Sanitation	Water Supply	Sanitation	Total
EAP	219.6	384.4	31.4	117.3	4.5	16.8	28.2	40.1	32.7	56.8	89.5
ECA	154.8	271.0	7.7	13.8	1.1	2.0	22.1	38.6	23.2	40.5	63.7
LAC	59.2	103.6	7.9	25.3	1.1	3.6	7.7	11.7	8.8	15.4	24.2
MENA	53.0	92.7	9.5	17.7	1.4	2.5	6.5	11.3	7.9	13.8	21.6
NA	57.4	100.4	3.4	5.5	0.5	0.8	8.1	14.2	8.6	15.0	23.6
SA	155.7	272.4	28.7	133.8	4.1	19.1	19.0	20.8	23.1	39.9	63.1
SSA	114.7	200.7	45.3	143.1	6.5	20.4	10.4	8.6	16.9	29.1	46.0
World	814	1,425	133.9	456.5	19.1	65.2	102.1	145.3	121.2	210.5	331.7

Source: Computed by the authors

The desired annual investment in water services infrastructure required during 2013-19 is presented in successive year's percentage of regional GDP (at constant 2005 prices) in Table 13. The country-wise GDP projections (in current prices, US$) is available upto 2019 from IMF (undated). The present analysis considers the projected GDP estimates in 2005 prices by using region-wise GDP deflator for 2012. It is observed from the table that in terms of relative importance (i.e., expressed as percentage of GDP), the desired investment will vary widely across regions and as compared to water supply, providing universal access to WSS would be quite costly for Sub-Saharan Africa and South Asia.

Table 13: Region-wise Estimated Annual Investment in Water Services Infrastructure as Percentage of GDP (in Constant 2005 Prices)

Regions	2012	2013	2014	2015	2016	2017	2018	2019
EAP	0.72	0.71	0.68	0.63	0.60	0.56	0.52	0.49
ECA	0.39	0.37	0.36	0.35	0.33	0.32	0.30	0.29
LAC	0.69	0.68	0.68	0.65	0.61	0.58	0.55	0.52
MENA	1.07	1.04	0.99	0.94	0.89	0.84	0.79	0.74
NA	0.15	0.15	0.14	0.14	0.13	0.12	0.12	0.11
SA	3.75	3.67	3.72	3.38	3.10	2.84	2.61	2.38
SSA	5.05	4.82	4.54	4.24	3.97	3.70	3.47	3.26
World	**0.63**	**0.61**	**0.59**	**0.56**	**0.54**	**0.51**	**0.48**	**0.46**

Source: Computed by the authors

In order to understand the long-term demand for investment in ensuring access to WSS, the present analysis has been extended further for two additional years, namely, 2025 and 2030. The results on additional investment requirements are presented in Table 14. It is observed from the table that if the period for achieving universal access is spread over a longer period, the demand for absolute value of investment would naturally go up, though the average annual investment requirement will be lower.

Table 14: Additional Investment (Capital) Required to Achieve Universal Access to Water and Sanitation (US$ Billion, 2005 Prices) (with reference to present 2012 stock of investment)

Regions	2025			2030		
	Water	Sanitation	Total	Water	Sanitation	Total
EAP	82.7	207.2	289.9	88.2	216.7	304.9
ECA	9.3	16.6	25.8	10.0	18.0	28.0
LAC	11.1	30.9	42.1	13.5	35.1	48.5
MENA	13.9	25.4	39.3	17.2	31.2	48.4
NA	5.8	9.8	15.7	7.8	13.2	21.0
SA	38.2	150.4	188.6	45.5	163.1	208.6
SSA	63.2	174.3	237.5	79.6	203.1	282.7
World	224.3	614.6	838.9	261.8	680.3	942.0

Source: Computed by the authors

The comparative investment requirement figures over 2012-19, 2012-25 and 2012-30 for securing universal access to WSS services are summarized in Table 15. The last rows of each column show the average annual investment requirement over the respective periods. As expected, the investment requirement is found to be highest for Sub-Saharan Africa, followed by South Asia and East Asia and the Pacific.

Table 15: Total and Annual Capital Investment Required to achieve Universal access to Water and Sanitation (US$ billion, 2005 prices) by 2019, 2025 and 2030

Regions	2012 to 2019	2012 to 2025	2012 to 2030
EAP	149	289.9	304.9
ECA	21	25.8	28.0
LAC	33	42.1	48.5
MENA	27	39.3	48.4
NA	9	15.7	21.0
SA	163	188.6	208.6
SSA	188	237.5	282.7
World	590	838.9	942.0
Equal Annual Investment	84.33	64.53	52.33

Source: Computed by the authors

4. Sources of Financing Infrastructure in Water Services

4.1 Concern Areas in Financing Infrastructure Projects: Public Funds

Public goods nature of services and various uncertainties often makes it difficult to mobilize resources, especially to attract private investors, to finance the infrastructure projects (e.g., roads, railways, power, water and sanitation). As a result, public financing of infrastructure remains the main source of funds for developing countries like India and the LDCs (Sengupta *et al*. 2015: 13). Unlike other infrastructure, WSS services have a special political economic dimension and at times it is provided free of costs to the stakeholders / beneficiaries (electorates), however uneconomic the policy might actually be. The falling fiscal space of governments, rising demands for public financing from other social merit goods (e.g. health and education), often leaves inadequate funds for financing water services infrastructure. Low public investment and low mobilization of resources from users and beneficiaries often tend to make the public WSS projects financially unviable.

The revenue stream of the infrastructure projects in general and WSS projects in particular depends on multiple factors, namely, the nature and stringency of water pricing, i.e., type of charges / fees (volumetric *vs*. lump sum), under-recovery of charges / fees due to political interventions / reluctance to charge water, humane nature of the service etc. The examples of political promises, with the objective of rich electoral dividends, abound in reality. Poor financial management and accounting practices is also another area of concern which results in pilferage of public resources away from WSS projects. Apart from budgetary resources, concessional / special loans, grants-in-aid from MDBs / agencies like the World Bank, ADB remain a major source of financing of WSS projects for developing countries like India and LDCs. In 2012, the WSS sector received official development assistance and non-concessional loans of US$ 10.5 billion and US$ 4.2 billion respectively, which included bilateral and multilateral aids as well as supports from NGOs and private foundations (UN-Water and WHO, 2014: 30).

4.2 PPI Investment in Water Services Sector

Given the aforesaid concern areas in securing public investment in WSS services, exploring the private investment route is of utmost importance. The present quantum and distribution of private investment in WSS sector would enable regions to accordingly strategize in their future initiatives. The distribution of private investment across the sub-regions can be observed by accessing the statistics from the Private Participation in Infrastructure (PPI) database of the World Bank (World Bank undated c).

The investment patterns across regions and various infrastructure sectors over 1991 to 2013 are summarized in Table 16. The table reveals that, only 3.4 % of the total investment in PPI projects has been channelized towards water and sewerage projects. In value terms, as amount of US$ 75 billion has been invested on water and sewerage projects (in historical prices) over this period, which looks pretty meagre as compared to other three infrastructure sectors reported in the table. It is further observed that the majority of the private investments undertaken in water infrastructure have moved to Latin America and the Caribbean and East Asia and Pacific regions. The poorer show by South Asia and Sub-Saharan Africa in attracting PPI investment therefore remains a major concern.

Table 16: Region-wise, Sector-wise Distribution of Investment in Projects (US$ billion) - 1991-2013

Sector	EAP	EUR	LAC	MENA	SA	SSA	Total Investment	
Energy (Electricity & Natural Gas)	152	127	282	25	159	22	767	(34.9)
Telecom	111	190	352	62	125	109	949	(43.2)
Transport	89	29	176	7	89	18	409	(18.6)
Water and sewerage	31	4	35	4	1	0	75	(3.4)
All	383	350	845	98	374	150	2,199	
	(17.4)	(15.9)	(38.4)	(4.5)	(17)	(6.8)	(100)	

Note: Figures in the parenthesis shows the percentage share in total investment
Source: Constructed by authors from World Bank (undated c) data

In order to analyze the evolving nature of the PPI investment on water services infrastructure across regions during 1991-2013, the data is presented in Table 17. It is observed that Latin America and the Caribbean and East Asia and Pacific regions have cumulatively attracted 46.6 % and 41.5 % of the total PPI investment, respectively. On the other hand, both Europe and Central Asia and Middle East and North Africa regions have attracted PPI investment of 5.3 % each. However, the regions which urgently require larger investment on water services infrastructure, i.e., Sub-Saharan Africa and South Asia, have attracted only 0.5 % and 0.8 % of the total investment, in that order. Interestingly, as the data reveals, major investment on water and sewerage sector was undertaken during 1996-2000, i.e., before the launching of the MDGs in September 2000. Last but not the least, it is further observed from the table that the PPI investment in Sub-Saharan Africa and South Asia has increased during 2011-13 over 2006-10 level only marginally. This is all the more worrying given the incomplete Water, sanitation and hygiene service delivery scenario in several Asian countries, including South Asia (Cronin *et al*., 2015: 227). The observation underlines the need to augment PPI investment on WSS services in these two regions in no uncertain terms.

Table 17: PPI Investment in projects by region and year of investment (US$ million)

Year of Investment	East Asia and Pacific	Europe and Central Asia	Latin America and the Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa	Total Investment	
1991-95	4,183	-	5,964	-	-	-	10,147	(13.6)
1996-2000	13,462	1,318	12,257	-	-	133	27,172	(36.5)
2001-05	6,784	1,013	3,433	679	113	12	12,034	(16.1)
2006-10	5,202	1,451	3,322	3,093	242	121	13,429	(18.0)
2011-13	1,316	133	9,745	192	251	126	11,762	(15.8)
All	30,947	3,915	34,721	3,964	606	392	74,544	(100)
	(41.5)	(5.3)	(46.6)	(5.3)	(0.8)	(0.5)	(100.0)	

Note: Figures in the parenthesis shows the percentage share in total investment

Source: Constructed by authors from World Bank (undated c) data

The anatomy of the PPI investment in water services infrastructure has been analyzed with the help of Table 18, where the investments have been categorized across sub-sectors and segments. It is observed from the table that 73.9 % of the total investment has come to the utility services, 23.2 % has targeted the treatment plant, and the remaining (2.7%) has targeted the water transfer system. It is evident that even within water services projects, the investment quantum is not evenly distributed across different functions.

Table 18: Number of projects and investment in water services projects by sub-sector (US$ million)

Sub-sector	Segment	Project Count	Total Investment	
Treatment plant	Potable water and sewerage treatment plant	13	292	(0.4)
	Potable water treatment plant	141	9,120	(12.2)
	Sewerage treatment plant	330	7,876	(10.6)
Total Treatment plant		**484**	**17,288**	**(23.2)**
Utility	Sewerage collection	2	174	(0.2)
	Sewerage collection and treatment	21	8,011	(10.7)
	Water utility with sewerage	264	35,807	(48.0)
	Water utility without sewerage	73	11,252	(15.1)
Total Utility		**360**	**55,244**	**(73.9)**
Total Water Transfer System		**3**	**2,013**	**(2.7)**
Grand Total	..	847	74,544	

Source: Constructed by authors from World Bank (undated c) data

Finally, the distribution of PPI investment across regions in WSS projects by establishment type has been analyzed for understanding the scenario on newer capacity creation and the results are summarized in Table 19. The table reflects that 64 % of the total PPI investment has so far been on concessions (also known as brownfield), while 13 % has come towards divesture (privatized). Interestingly, PPI investment in greenfield projects has been quite low (21 %). However, a saving grace is that in Sub-Saharan Africa, investment in greenfield projects explain a significant proportion of the total investment (66.07%). Conversely, in South Asia the corresponding figure stands only at 40.50%.

Table 19: Investment in projects by region and type (US$ million)

Region	Concession	Divestiture	Greenfield project	Management and lease contract	Total
EAP	23,315	1,321	6,167	143	30,945
ECA	731	435	1,544	1,205	3,915
LAC	22,982	7,924	3,812	5	34,724
MENA	192	0	3,772	0	3,964
SA	359	0	245	2	605
SSA	76	0	259	57	392
Grand Total	47,654	9,680	15,798	1,412	74,545
	64	13	21	2	100

Source: Constructed by authors from World Bank (undated c) data

Notes: *Concessions* - A private entity takes over the management of a state-owned enterprise for a given period during which it also assumes significant investment risk; *Divestitures* - A private entity buys an equity stake in a state-owned enterprise through an asset sale, public offering, or mass privatization program; *Greenfield Projects* - A private entity or a public-private joint venture builds and operates a new facility for the period specified in the project contract. The facility may return to the public sector at the end of the concession period; and *Management and Lease Contracts* - A private entity takes over the management of a state-owned enterprise for a fixed period while ownership and investment decisions remain with the state.

4.3 Financing the Investment Gap in Water Services Infrastructure

OECD (2011: 52) describes the current water service finance architecture in terms of cost and revenue components. While the three major cost components are investment, operating and maintenance costs, revenues are earned through the 3Ts, namely, tariffs (i.e., user charges), taxes (budgetary resources) and transfers (e.g., overseas development assistance, grants-in-aid from higher level of government in case of federal countries, long-term loans from multilateral development institutions like World Bank, ADB etc.). The public water supply agencies often issue bonds (guaranteed by state government), obtain loans and advances from the appropriate government etc. to meet the finance gap in WSS projects. The countries in South Asia and Sub-Saharan Africa urgently need to enhance their budgetary provisions towards WSS services. However, as most of them suffer from limited fiscal space and are faced with competing development agendas, meeting such costs exclusively through public funds would not be possible.

Palaniappan et al (2007: 278) notes that private capital plays a limited role in OECD countries. Given the finance gap, there is however an urgent need to augment private participation in financing WSS projects in the regions like Sub-Saharan Africa and South Asia. However, it is contingent on the existing legal framework on protection of investment to promote the private participation in infrastructure projects. WHO (2012: 3) have underlined the need for promoting services that are, 'both socially efficient and financially sustainable'. As most of the countries in dire need of finance in WSS services are either LDCs or developing countries, financial sustainability is not automatically assured. Moreover, it is unlikely that participation of the domestic private sector will be able to supplement the investment requirement gap. Encouraging participation of foreign investors, either from the developed countries or advanced developing countries, might be a prudent step in this background. Presently privatization of WSS is happening in developing countries, with entry of both domestic and foreign players in key markets, but the quantum has been inadequate.

A series of reforms are required in several South Asian and Sub-Saharan African countries before the possibility of obtaining private investments from abroad can indeed become a reality. First, the legal framework on foreign investment protection needs to be strengthened in the recipient country. For instance, many developing countries / LDCs have bilateral investment treaties (BITs) with other countries, but the extent of actual market access can be quite restrictive owing to the inherent provisions in the agreement (Chaisse and Bellak, 2011: 7-8). Second, protection of intellectual property rights through necessary procedural modifications would be crucial, if the foreign firm enters the market with certain key technology (e.g. water treatment technology). Third, often the market in developing countries and LDCs are considered risky by foreign investors, laden with political crisis, non-transparency, macroeconomic instability, expropriation risks etc. A major reform of the policy environment is required for changing the perceived risk by investors. Finally, the governments may subject foreign investment proposals in WSS service to case-by-case review, instead of putting a blanket ban (UNCTAD, 2015: 124).

Given the public good nature of the infrastructure sector, where the problems of market failure and revenue mobilization are enormous, Public-Private Partnership (PPP) model provides a robust option for raising the necessary investment. Here both the public and private partners can focus on their respective specific competences. There is need to identify and implement the recipe of successful PPP models, through introduction of 'user-pay' approach. World Bank (2012: 1-3) recounts the success of water service PPPs in Sub-Saharan and other African countries characterized by civil law, where 'legal systems that have statutes and codes regulating public service contracting'. WSP (2011: 5-11) notes that number of water-related PPP projects reaching award stage in India is on the rise in recent period. While factors like availability of public support, integration of mechanisms to address revenue mobilization, ownership and expertise of state agencies add to their success, the projects sometimes suffer from limitations like inconsistent and inadequate local stakeholder support, limited awareness and technical capacity to undertake PPPs etc.

Last but not the least, the investment strategies in general and in WSS services in particular need to facilitate the ongoing climate change mitigation policies through appropriate actions (e.g., deployment of climate-friendly technologies, prohibiting exploitation of natural resources). UNCTAD (2015: 127) argues in favour of shifting towards 'sustainable-development-based' incentives for investments from a purely 'location-based' approach.

5. Conclusions

It is evident from the analysis so far that different regions are at different levels of achievement in securing universal access to WSS services. Faced with the problem of growing population size and inadequate WSS services infrastructure in an age of urbanization, the importance of investment demand has become apparent in several parts of the globe, particularly in South Asia and Sub-Saharan Africa. Moreover, the WSS services should not be treated in isolation, but through an integrated approach so as to enhance the livelihood security of the people on one hand and prevent contamination risks on the other. The present analysis is an attempt to estimate the demand for such investments.

The empirical estimates of the analysis reveals that to achieve universal access to improved WSS by 2019, the stock of investment in water services should reach US $2,240 billion at 2005 prices in 2019. At the given stock of investment in 2012, an additional investment of US$ 590 billion (US$ 134 billion in water supply and US$ 456 billion in sanitation) would be required in new water services infrastructure to reach the desired stock of investment by 2019. In addition to new investment for infrastructure, additional investment of US$ 247 billion is required for repair and replacement activities. Therefore total investment in water services infrastructure required during 2013-19 would turn out to be US$ 838 billion. If the investment is spread out evenly over the entire period of planning (i.e., 2013-19), an average annual investment of US$ 34 billion in water supply and US$ 86 billion in sanitation would be required to achieve the universal access to improved water source and sanitation by 2019. The cost estimates would go up further if the climate change aspects are to be integrated in the calculations.

In the backdrop of the huge investment requirements, and the urgency of interventions in low income countries located in South Asia and Sub-Saharan Africa facing rapid urbanization, it is unlikely that the government budgetary devolutions and the aids from bilateral and multilateral donors would be able to bridge the gap. Attracting private investment in this field needs to be part of the long-term solution. To facilitate the process, certain strong measures are urgently required. In particular there is need for improving the politico-legal framework for facilitating private sector investment protection as well as devising efficient mechanisms for cost recovery.

Given the poor access scenario, simultaneously with the process of arranging for the necessary investment, the countries must also embrace certain policies. First, UN-Water and WHO (2014: 14) notes that 70 and 63 countries (out of 94 respondents) have incorporated the human right to water and sanitation respectively in their constitution. There is a need for all the UN member countries, especially the countries presently with poorer access, to undertake similar step at the earliest to recognize human right to water and sanitation as fundamental rights. Second, so far only around 50% of countries are implementing specific measures for reusing wastewater in their national plans, while the practice have become widespread only in around 2% of countries (UN-Water and WHO, 2014: 26). Greater focus needs to be accorded in this area as well, as environmental degradation due to sewage discharges and wastewaters remains a major area of concern in several low and middle income countries (Ashley and Cashman, 2006: 253). Third, innovations are required to facilitate operation of desalination plants at lower cost in at least some of the countries with poor access to drinkable water but a sizable coastline. Fourth, increased focus to biotechnology research is required to facilitate cultivation of drought-resistant crops and other similar innovations, thereby balancing demand for water to some extent (Ashley and Cashman, 2006: 290). Similar water-saving innovations would be required in the industrial sector as well. Fifth, with the global climate change effects intensifying, untimely freak torrential rains and droughts are becoming a recurrent phenomenon in recent times. There is a need to integrate stormwater and rainwater management practices with the wider urban planning approach through the necessary legal and administrative steps (Cettner *et al*., 2013: 790-96; Yazdanfar and Sharma, 2015: 169-71). Finally, disputes over water right issues are common when rivers flow across the border, as one country's attempt to enhance access within its territory may lower the same in neighbouring countries. For instance, the recent building of dams over the Brahmaputra River in China and the concerns in India over future water flows deserves mention. The emerging concern is that even if the country located upstream agrees to release annually an assured amount of water, the disputes may subsequently turn far more complex with varying water flows in the river as consequence of climate change. Hence it is extremely important to develop necessary bilateral institutional mechanisms for mitigating water allocation conflicts in mutual interest (Diner *et al*., 2014: 19-21).

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