



**GCE A level**

1204/01-B

**GEOGRAPHY – G4  
SUSTAINABILITY**

**Pre-Release Material for examination  
on 23 January 2013.**

**To be opened on receipt.**

**A new copy of this Folder will be  
given out in the examination.**

# **RESOURCE FOLDER**

## **INSTRUCTIONS TO CANDIDATES**

**A new copy of this Folder will be given out in the examination. This copy must not be taken into the examination.**

Work through this Folder to make sure you understand all the resources. You may seek help from your teachers or any other sources in this context. You have to apply your critical understanding to an unfamiliar situation.

## **ADVICE TO CANDIDATES**

The main focus of the materials in this Resource Folder is related to different types of city and the sustainability of water supply and demand in cities. The cities of Toronto and Nairobi are given particular attention. Wider issues of future water supply and demand and of city development are also examined.

### **Guidelines for using the pre-release materials**

The contents of the booklet should be studied carefully. The examples given will help in answering some of the questions on the question paper. To give a fuller answer, it is advisable to look at other material before the examination. This could be similar topics, related to information in other countries, or may be the same countries but in greater depth or on closely related topics. It would be particularly useful to note if other case studies seem similar in nature, or if they show contrasting perspectives to those from the material in this Resource Folder.

Some of the resource materials come from Geography textbooks, but others come from companies, pressure groups, research organisations, governments and private individuals. In some cases they are using information to promote their own interests rather than to represent an impartial view. It is worth considering if they are trying to support a particular interest group and persuade readers to agree with them. In finding other materials, it is worth bearing in mind that they might not be presented in an impartial and objective way.

Material in the Resource Folder may often be related to other themes found in G4, and to other units in Geography AS and A2. These links should be noted, as there will be opportunities to refer to such connections with other work in some of your answers. Being able to link together different parts of your Geography studies is important and will be credited. Such linkages are sometimes referred to as 'synopticity'.

Textbooks, journals, good quality newspapers and television and radio programmes are good sources of information. Probably the most accessible source of geographical information is the Internet, but it is also the one which may be most susceptible to bias and lack of impartiality. Many of the resources are extracted or adapted from sources on the Internet. These sources have the web addresses provided for copyright reasons. Many are only extracts or shortened versions of fuller documents and some may be inaccessible by the date of the release of this Resource Folder. Following some of these links for greater depth of reading and for more recent updates of material can be helpful but is not essential.

Each candidate will be provided with a copy of the Resource Folder, for use in the examination, at the same time as the question paper is issued at the beginning of the examination on the day set for the paper.

**Copies of the Resource Folder with added notes, or notes from research carried out in the previous six weeks, may not be taken into the examination.**

## Contents

		Page
<b>CITY BACKGROUNDS</b>		
Figure 1	Background to Toronto	4
Figure 2	Background to Nairobi	5
Figure 3	The Globalisation and World Cities group (GaWC) classification	6
Figure 4	Population growth rates in selected cities	6
Figure 5	Unemployment rates in selected cities throughout the world	7
Figure 6	Liveability scores and ranking	7
<b>WATER SUPPLIES</b>		
Figure 7	Toronto's water supply	8
Figure 8	Simplified cross-section of the aquifer under the Toronto region	8
Figure 9	Nairobi's water supply	9
Figure 10	Simplified cross-section of the aquifer under Nairobi	9
Figure 11	Annual average precipitation and temperature graph for Toronto	10
Figure 12	Treatment of water from Lake Ontario before entering Toronto's water supply	10
Figure 13	Annual average precipitation and temperature graph for Nyeri	11
Figure 14	The characteristics of Nairobi's water supply	11
Figure 15	Water wells in the Nairobi area 1997 to 2001	11
<b>FUTURE WATER DEMAND</b>		
Figure 16	Past and projected water demand for Toronto	12
Figure 17	Influences on Toronto's future water demand	12
Figure 18	Past and projected water demand for Nairobi	13
Figure 19	Extract from Nairobi Chronicle March 2011	13
Figure 20	Water and development in Kenya	13
<b>FUTURE WATER AVAILABILITY</b>		
Figure 21	The main elements of the water cycle	14
Figure 22	Relationship between temperature and evaporation	14
Figure 23	Rainfall variability in the future	15
Figure 24	Past and projected rainfall variability over central Kenya	15
Figure 25	Predicted change in rainfall patterns in Canada	15
<b>WATER CONSERVATION</b>		
Figure 26	Water conservation in Canada	16
Figure 27	Water conservation in Kenya	16
<b>POTENTIAL NEW SOURCES OF WATER</b>		
Figure 28	Desalination of sea water	17
Figure 29	Cloud seeding	17
	Sources of information and copyright	18

## CITY BACKGROUNDS

### Figure 1 Background to Toronto

Toronto is the largest city in Canada, and has a population of 2.7 million, with a further 2.8 million people who live and work in the city region. It is the fifth largest urban area in North America.

Although Ottawa is the political capital of Canada, Toronto has many of the functions expected of a capital city. It is Canada's leading city for television, film making, publishing, media and the arts. It is also the main centre in Canada for education, medical research, and computer software.

It is home to Canada's Stock Exchange and has many other financial services such as banking and insurance located there. The Toronto Stock Exchange is the 7th largest in the world with about US\$ 1608 billion stock. In 2008, Toronto was classified as an alpha world city by the Globalisation and World Cities group (GaWC). Alpha is the third highest ranking out of eleven (see Figure 3, page 6).

Toronto is regarded by many people as a very pleasant place to live. The Economist Intelligence Unit (EIU) Liveability score for Toronto in 2009 was 97.2, putting it in 4th place for all cities in the world (see Figure 6, page 7). The highest ranking city in the UK is Manchester, scoring 90.0, which is in 46th place.

Sources: [www.toronto.ca](http://www.toronto.ca); [store.eiu.com](http://store.eiu.com); and adapted from [www.mercer.com](http://www.mercer.com)



Toronto CBD and Lake Ontario

Source: ©Gheorghe Roman/Shutterstock



Location of Toronto

## Figure 2 Background to Nairobi

Nairobi is the largest city in Kenya and is also its capital. In 2009 it had a population of 3.14 million, which is growing rapidly, as it was 2.75 million in 2005. There are large areas of informal settlement within the city, for example, Kibera is home to around 1 million people.

Nairobi generates almost half of Kenya's GDP. Most industries are small or medium in size and many are related to tea and coffee production in rural areas. Manufacturing is growing slowly, but remains only a small part of the economy. Tourism is important to the city generating about half of its income. Most visitors coming to see Kenya's wildlife spend some time in Nairobi.

There is a stock exchange in Nairobi which, although small, is growing. It is the 4th most important stock exchange in the African continent, but only represents about US\$ 11 million. In 2008, GaWC ranked Nairobi as a gamma+ city, which is 8th out of the eleven rankings.

Having much informal settlement and low living conditions for the majority of people, Nairobi scored 54.8 on the Liveability index in 2009, and ranked 122nd in the Economist Intelligence Unit's Rankings.

Source: UNhabitat



Nairobi CBD with suburbs in background

Source: ©Kondrachov Vladimir/Shutterstock



Location of Nairobi

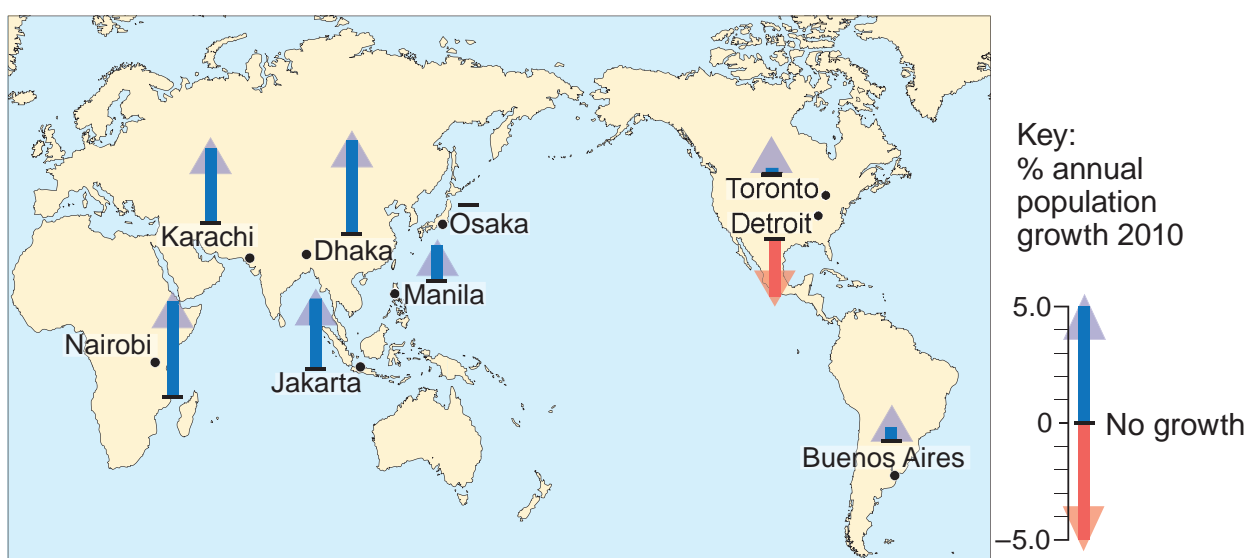
**Figure 3 The Globalisation and World Cities group (GaWC) classification**

256 cities are assessed by how well their advanced services interconnect with other important cities throughout the world. It measures their degree of integration into the world city network and is a measure of their importance. There are eleven levels, which are;

City level	Degree of globalisation	Example
1 Alpha++	Highly integrated with all major cities	London
2 Alpha+	Highly integrated with other cities	Sydney
3 Alpha	Cities linking several major economic regions	Toronto
4 Alpha-	Cities linking some major economic regions	Warsaw
5 Beta+	Cities that link many important regions to the world economy	Manila
6 Beta	Cities that link several important regions to the world economy	Karachi
7 Beta-	Cities that link a few important regions to the world economy	Detroit
8 Gamma+	These link several smaller regions to the world economy	Nairobi
9 Gamma	These link smaller regions to the world economy	Leeds
10 Gamma-	These link a few smaller regions to the world economy	Curitiba
11 Cities with sufficiency of services	These are not world cities, but have services for their local area, but without important links to the world economy	Utrecht

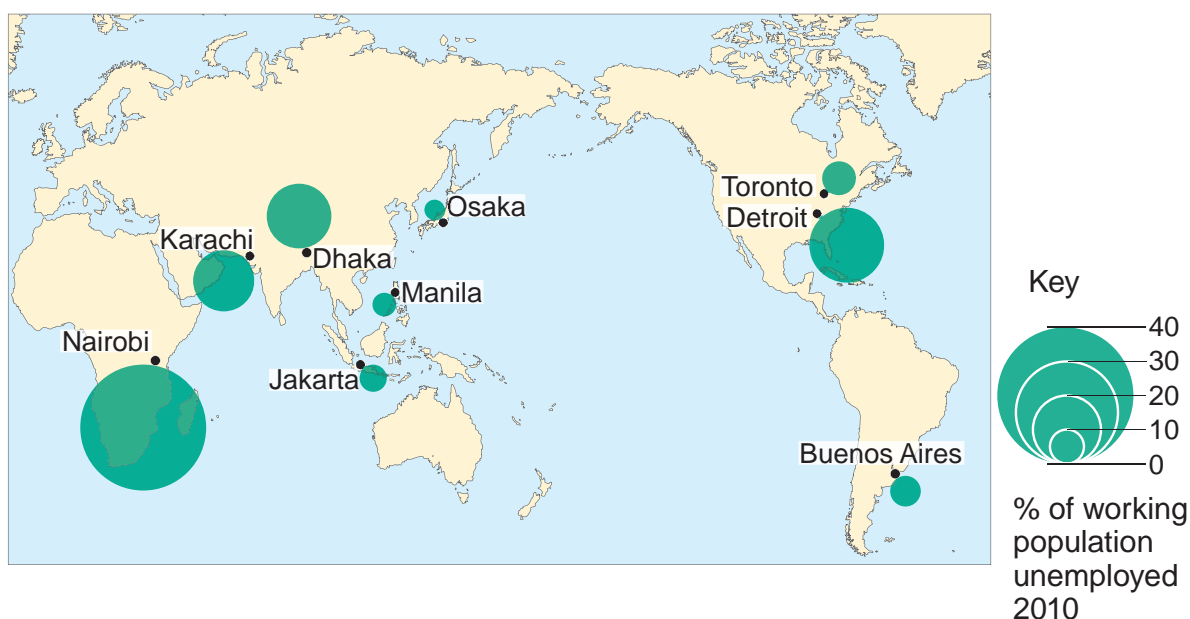
Source: [www.lboro.ac.uk](http://www.lboro.ac.uk)

**Figure 4 Population growth rates in selected cities**



Source: adapted from *webarchive*

**Figure 5 Unemployment rates in selected cities throughout the world**



Source: adapted from [www.citymayors.com](http://www.citymayors.com)

**Figure 6 Liveability scores and ranking**

The Economist Intelligence Unit gathers data on education, healthcare, infrastructure (which includes water supply), culture and environment, and stability (based on crime, civil unrest and conflict), to give each city a score out of 100.

A score of 100 means a city that is ideal and as near perfect to live in as is possible. A score of 1 would mean that it would be intolerable to live there.

Currently, 140 major cities throughout the world are included in the survey. As well as giving a score out of 100, the cities are usually put into rank order. For 2009 some examples are;

City	Rank	Liveability score
Vancouver	1	98
Toronto	4	97
Madrid	39	91
Moscow	69	78
Rio de Janeiro	92	69
Cairo	114	59
Nairobi	122	55
Dhaka	138	39

Source: [storeeiu.com](http://storeeiu.com)

## WATER SUPPLIES

**Figure 7 Toronto's water supply**



The main source of water for Toronto is Lake Ontario. This is an almost infinite source. The lake provides 1 250 000 cubic metres of water per day. However, the lake is becoming increasingly polluted and much filtering and treatment is needed before it can be used.

Between 10% and 15% of the water drawn from the lake comes from a depth of 80 metres or more. At that depth, water is at a constant 4°C throughout the year. As well as providing a water supply, it is cold enough to assist with air conditioning throughout the city.

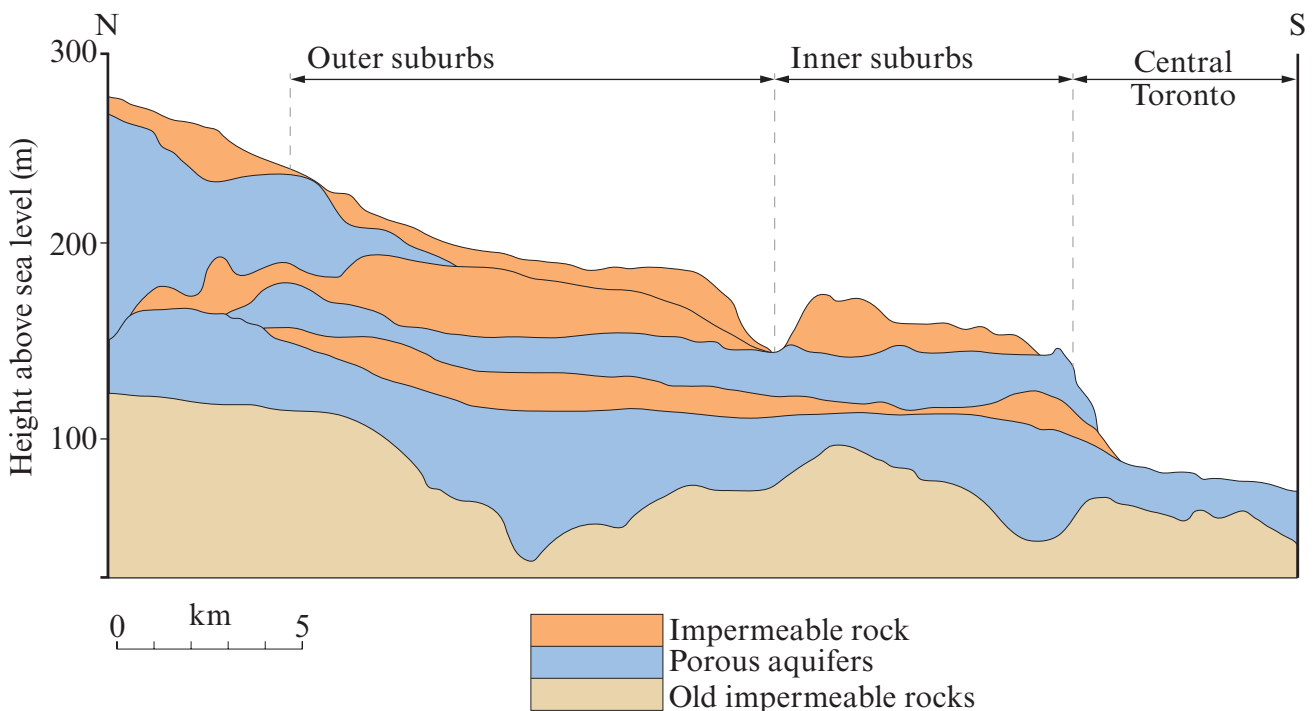
Two rivers close to Toronto provided the city's original water supply, but they have been polluted by industry and urban runoff and are no longer used.

Pure, clean water can also be found in aquifers. Boreholes have been drilled down into the aquifers to pump up water supplies. Extraction has not exceeded the rate of replenishment so far. This provides less than 1% of the city's needs.

A pipeline drawing water to the shore from deep in Lake Ontario

Source: <http://buildipedia.com>

**Figure 8 Simplified cross-section of the aquifer under the Toronto region**



Source: adapted from Don River Watershed Plan



**Figure 9 Nairobi's water supply**



The main source of water for Nairobi is from rivers which rise in mountains to the north of Nairobi. The two most important rivers have their source in the Aberdare National Park.

This park has very little human interference and the water quality is extremely high.

The rivers have a series of dams along them to store water. None of the dams near Nairobi are very large. Water from these dams is piped to Nairobi.

These rivers supply around 485 000 cubic metres of water per day. More could be abstracted, but this would deplete supplies further downstream which are mainly needed for agriculture.

Nairobi and the Aberdare National Park

The second most important source of water for Nairobi is from an aquifer under the city. The aquifer extends to the north of the city too.

The aquifer is recharged by rainfall in the southern part of the Aberdare National Park and on land further south.

The aquifer provides 570 000 cubic metres of water per day. This amount of abstraction is in balance with the recharge. Increased abstraction would deplete it.

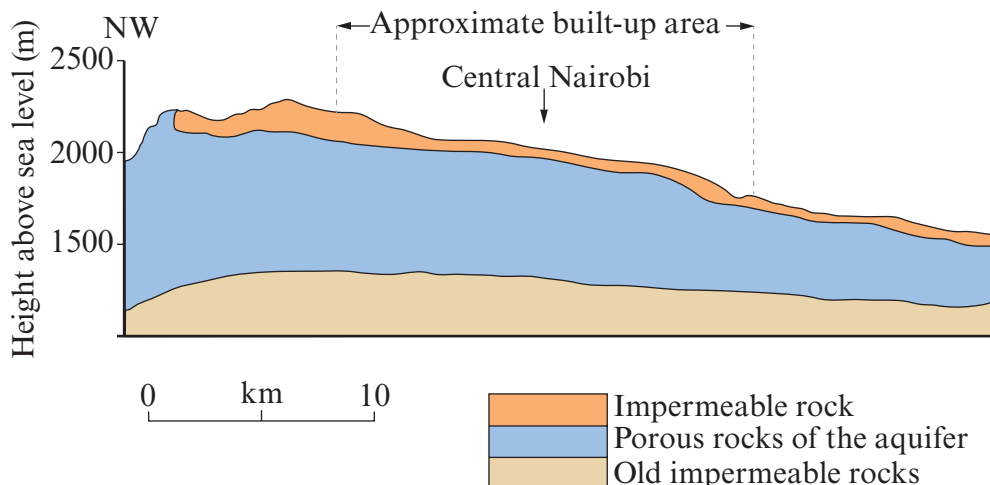
Land to the south of the national park is increasingly being used for agriculture. There are concerns that the amounts of pesticides entering the aquifer are rising.



Tana River near Nairobi

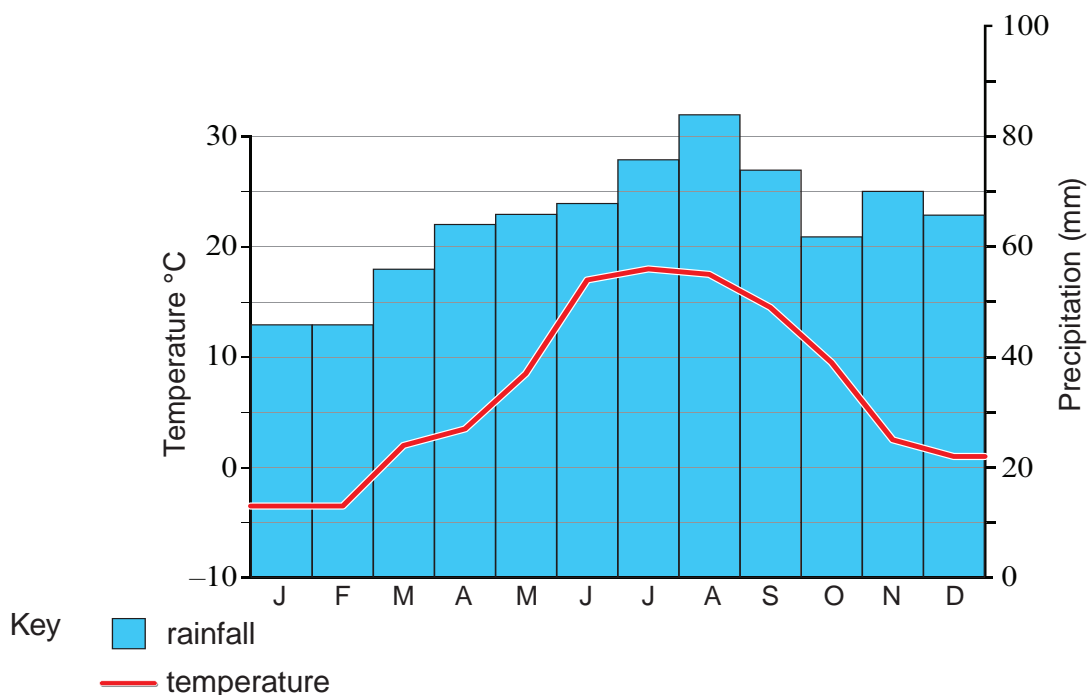
Source: ©2012 Fred Hoogervorst

**Figure 10 Simplified cross-section of the aquifer under Nairobi** SE



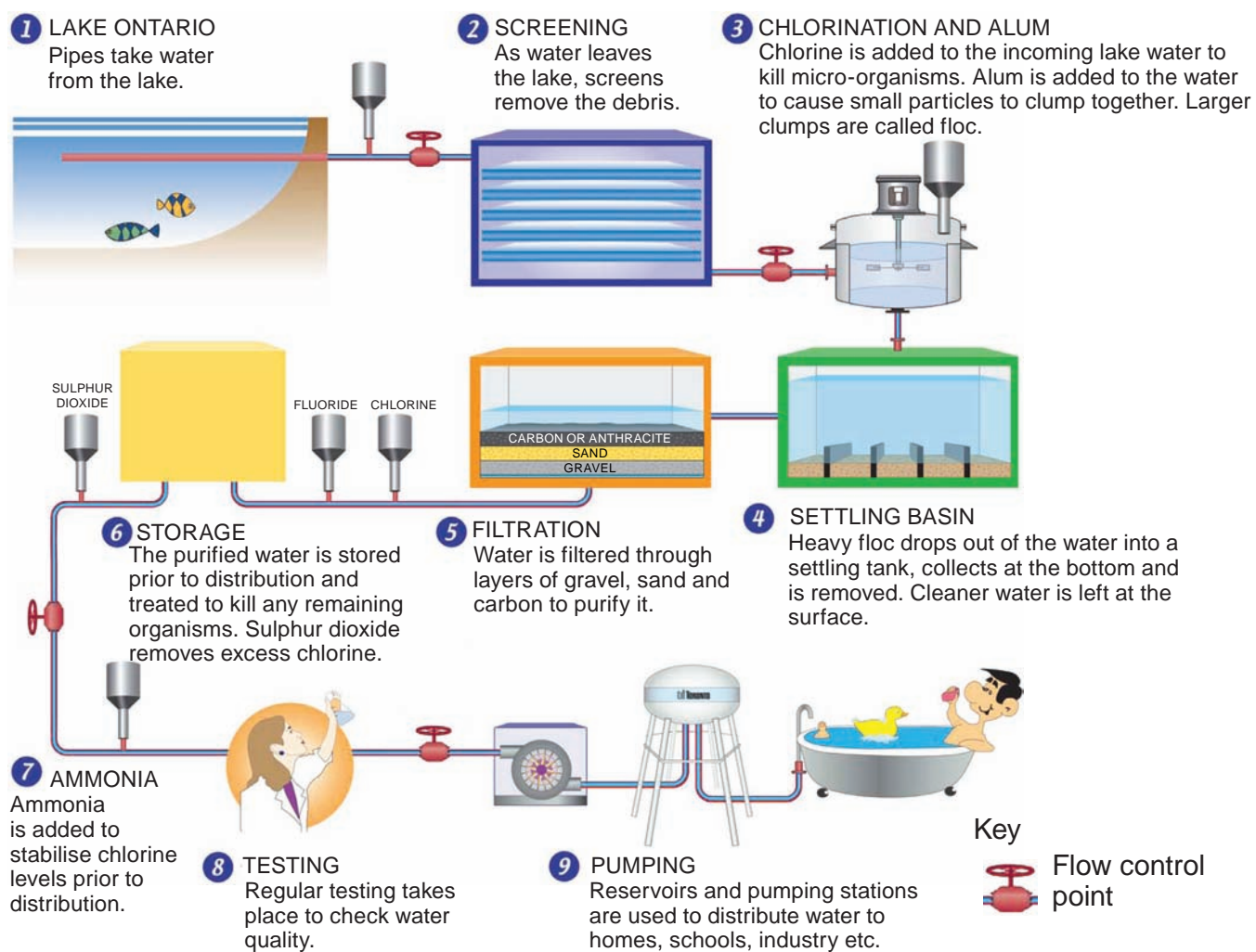
Source: World Bank

Figure 11 Annual average precipitation and temperature graph for Toronto

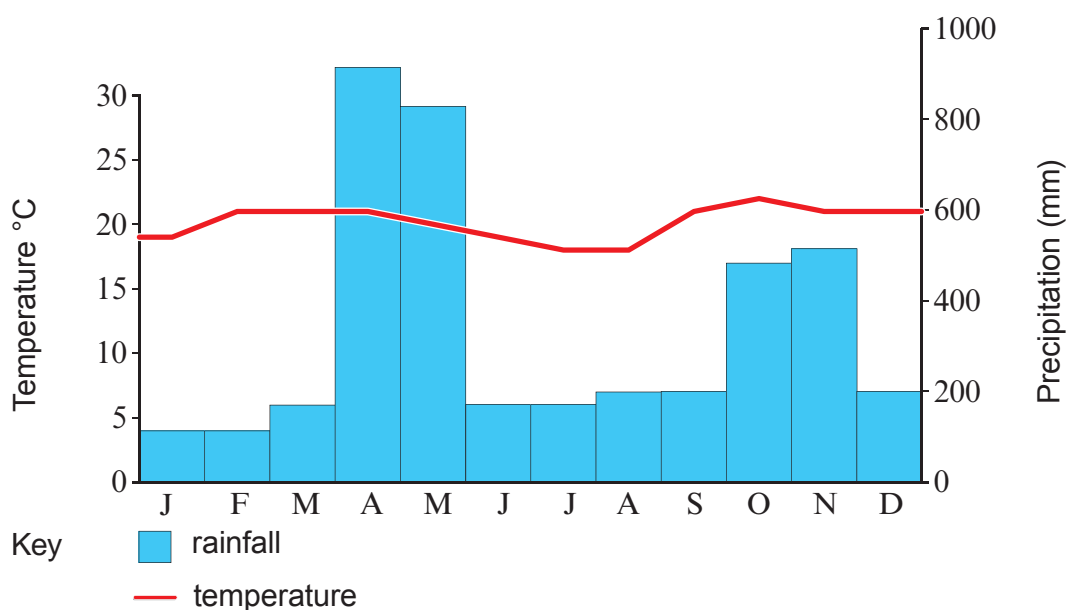


Source: toronto-yyz

Figure 12 Treatment of water from Lake Ontario before entering Toronto's water supply



Source: www.toronto.ca

**Figure 13 Annual average precipitation and temperature graph for Nyeri\***

Source: [www.world66](http://www.world66)

\*Nyeri is located near Aberdare National Park (see Figure 9)

**Figure 14 The characteristics of Nairobi's water supply**

- Sufficient under normal conditions – water supply for Nairobi is not reliable during periods of drought.
- Supply being endangered by siltation in the reservoirs. Made worse each year from increasing deforestation within the catchment areas.
- 60% of Nairobi's population live in areas where water has not been treated to be clean and safe.
- Supply problem aggravated by the poor state of the distribution system. Results in about 50% losses due to leakages and illegal connections to the supply.
- Inefficient and wasteful use of water by some consumers. Rationing of water, but the majority of people find ways to avoid this.

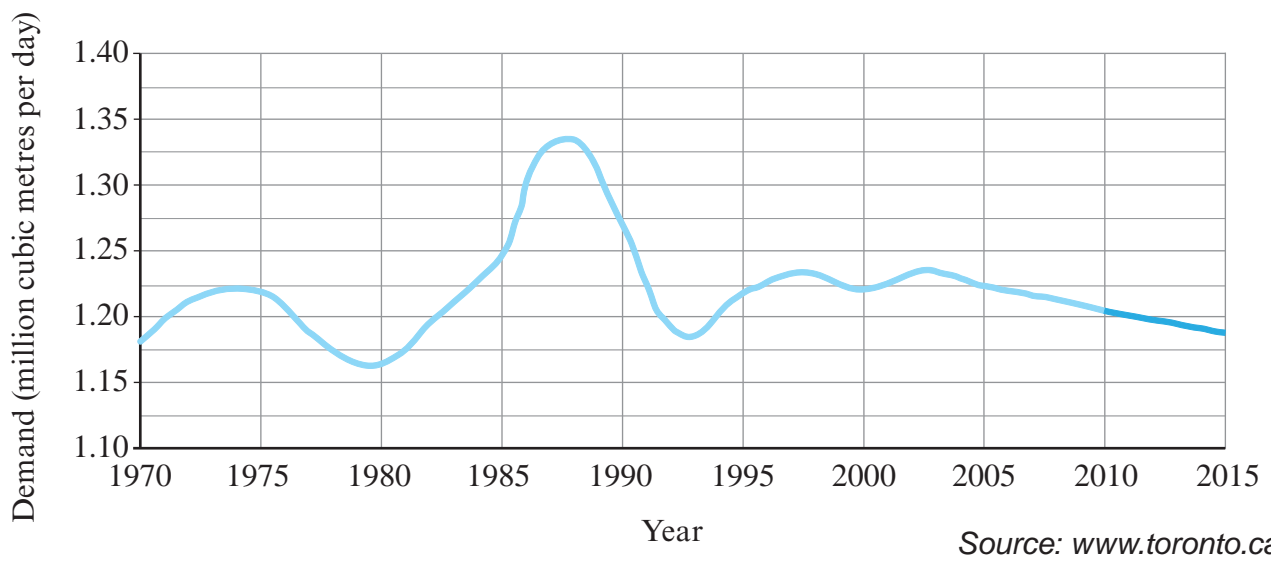
**Figure 15 Water wells in the Nairobi area 1997 to 2001**

YEAR	1997	1998	1999	2000	2001
number of water wells	32	32	44	61	97
average depth (m)	221	209	218	227	238
average depth of water table (m)	96	86	97	109	106
average initial pumping yield (m <sup>3</sup> /hr)	8	9	8	11	12

Source: [worldbank.org](http://worldbank.org)

### FUTURE WATER DEMAND

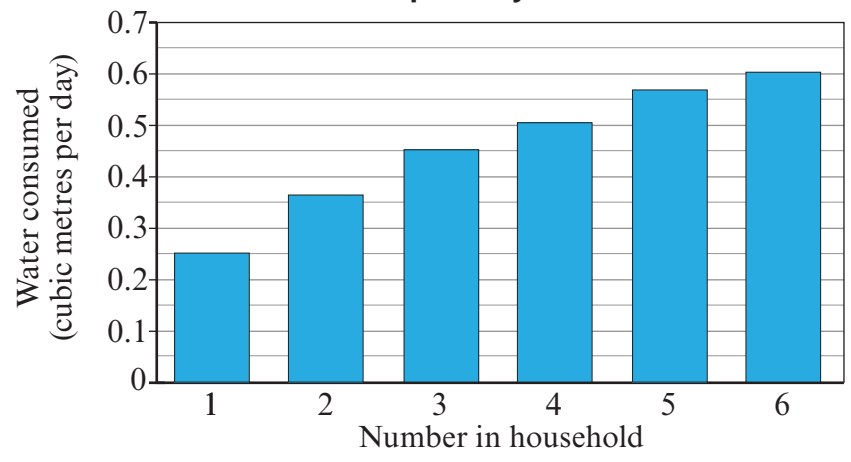
**Figure 16 Past and projected water demand for Toronto**



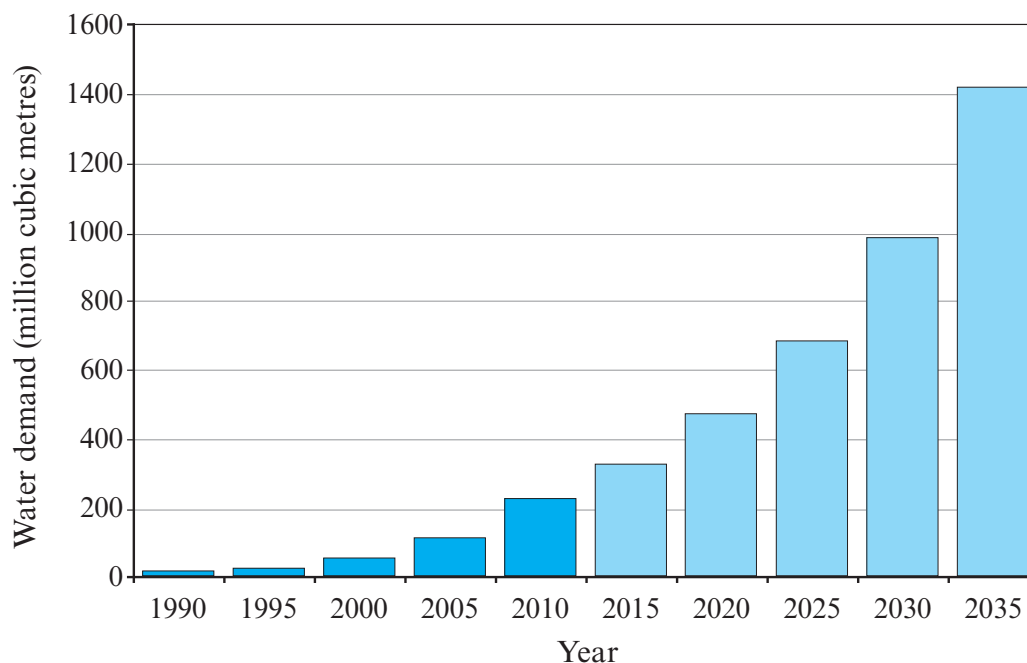
**Figure 17 Influences on Toronto’s future water demand**

- Population – From 2013 onwards, population is expected to grow by 20 000 people per year.
- Demographics – Population getting older, so smaller proportion will be employed.
- Housing age – Older housing, with inefficient water fittings, gradually being replaced by more modern, efficient dwellings.
- Housing type – Number of apartments in blocks is likely to remain constant. New accommodation likely to be detached housing with large gardens.
- Employment – A 10% increase in the number of people employed expected from 2013 to 2020.
- New jobs – Most in the service sector, manufacturing will continue to decline.
- Household composition – The number of persons per dwelling is falling. More dwelling units are needed to accommodate the same number of people.

**Current water consumption by household size in Toronto**



*Source: adapted from www.toronto.ca*

**Figure 18 Past and projected water demand for Nairobi**

Source: [www.weap21.org](http://www.weap21.org)

**Figure 19 Extract from Nairobi Chronicle March 2011**

### Thirsty city in the sun

As the water shortage continues to bite, the Nairobi City Council's failure to monitor illegal connections, and misuse of water, will continue to hamper any plans to supply city residents with sufficient amounts of water.

Though accustomed to perennial water shortages, the opinion of Nairobi city residents is that the current scarcity, which began in early May 2009, with no signs of relenting soon, is a sure cause for alarm.

The current shortage was precipitated by flash floods in the Aberdare National Park. The huge discharge moved boulders that caused damage to several dams which are major suppliers of water to Nairobi. Pebbles, sand and mud have clogged tunnels and pebbles have broken supply pipes. Some of the damage has been repaired with the help of the army, but water supply in the city has not returned to normal.

The poor have been particularly hard hit. 'We wake up as early as 6.00 am in search of water. We do not go for Sunday service. We spend the whole day without meals and can only manage to get one small can of water. We have gone for days without a shower,' lamented one resident of the city's Kibera slum.

Source: [nairobichronicle.wordpress.com](http://nairobichronicle.wordpress.com)

**Figure 20 Water and development in Kenya**

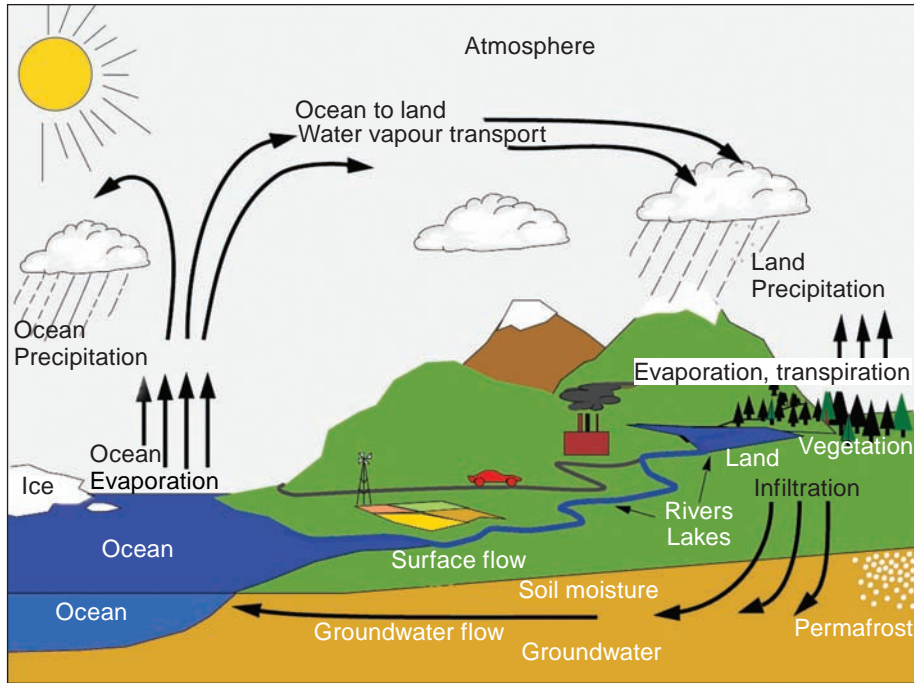
Water supplies need to be increased for Kenya to develop. There is the need to supply enough water and food for the growing population. Exports depend heavily on agriculture which needs water to increase production.

Cities are growing in size and need more water both to provide basic necessities to all and to cater for a growing affluent minority. The cities are developing new industries. Water is needed for production processes and cooling in many of these industries.

Source: adapted from [www.ecfa.or.jp](http://www.ecfa.or.jp)

**FUTURE WATER AVAILABILITY**

**Figure 21 The main elements of the water cycle**

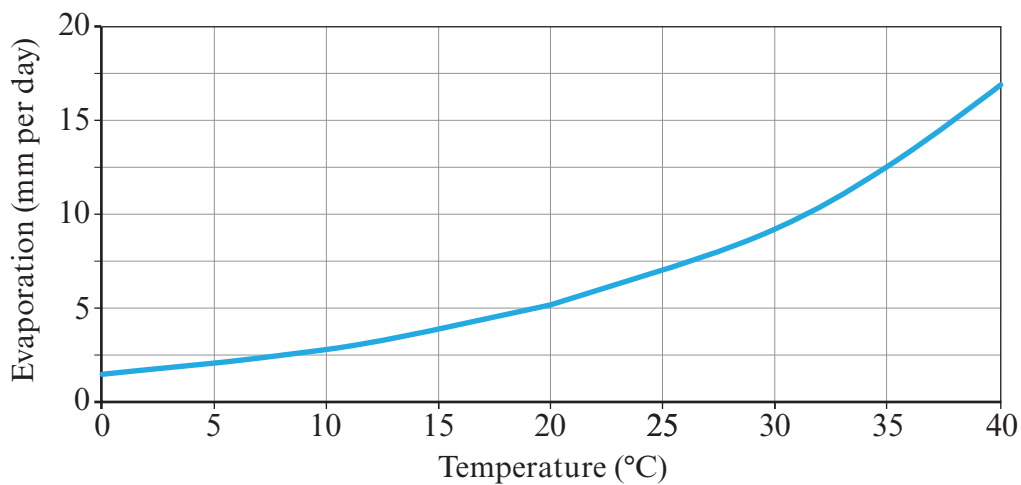


Source: adapted from [www.tiimes.ucar.edu](http://www.tiimes.ucar.edu)

The main challenges for maintaining or increasing water supplies in the future are:

- Preventing surface flow running off too quickly.
- Ensuring groundwater use does not exceed the rate at which it can be replenished.
- Evaporation of stored water, especially if global warming increases temperatures.

**Figure 22 Relationship between temperature and evaporation**



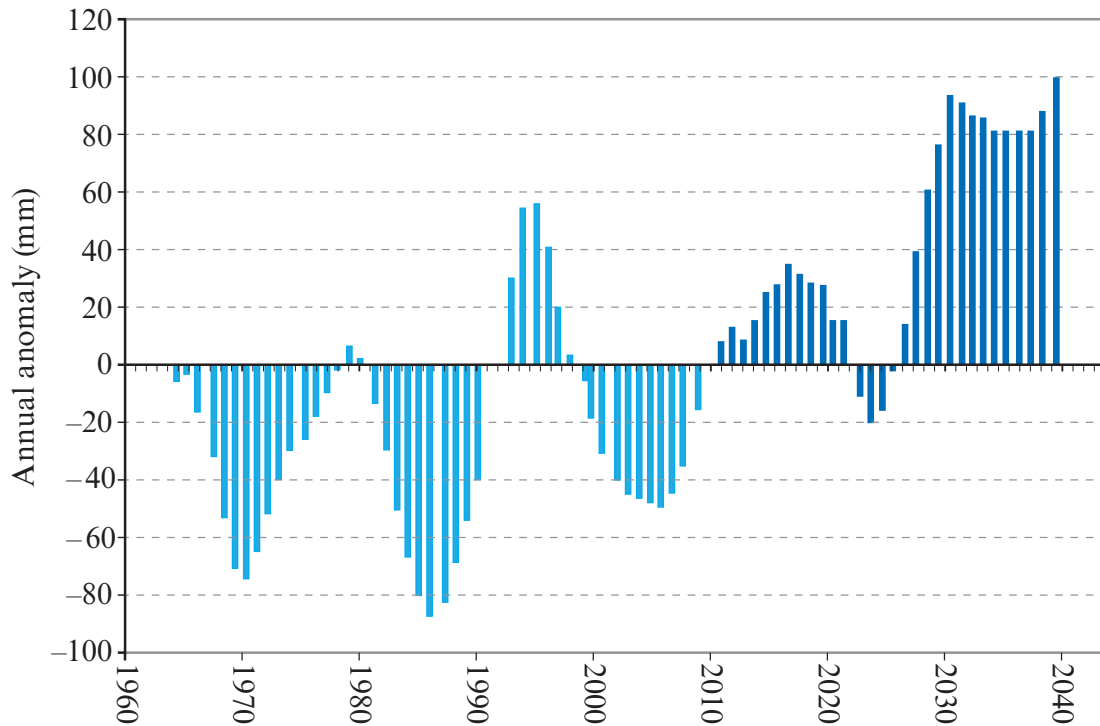
This graph is for evaporation in still air at 80% relative humidity.

Source: adapted from [www.ctahr.hawaii.edu](http://www.ctahr.hawaii.edu)

### Figure 23 Rainfall variability in the future

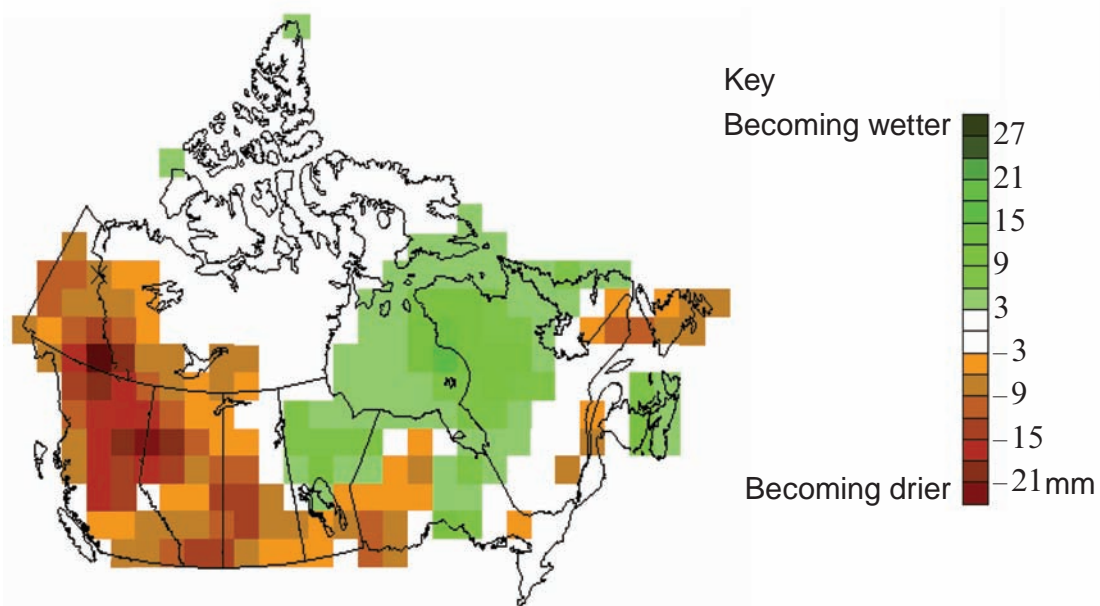
Rainfall variability is key to agricultural production and economic growth in many developing countries. In many places rainfall variability is amplified (even where the total amount of rain increases) as a result of climate change. Changes in rainfall will also increase variability in groundwater recharge and river flow, thus affecting all water sources.

**Figure 24 Past and projected rainfall variability over central Kenya based on average rainfall collected between 1900 and 1950**



Source: [www.iisd.org](http://www.iisd.org)

**Figure 25 Predicted change in rainfall patterns in Canada, 2010-2030, based on figures collected 1950-1999**



Source: [ccsn.ca](http://ccsn.ca)

## WATER CONSERVATION

**Figure 26 Water conservation in Canada**

As well as predicting future water demand, Toronto is planning several water conservation measures. Some of these are by the local authority (municipal), some by people in houses (single-family residential), some for people in blocks of apartments (multi-unit residential) and by businesses (industrial, commercial and institutional).

Measure	Local authority	Residential	Industrial
Computer-controlled irrigation	✓		
Toilet upgrading		✓	
Washing machine upgrading		✓	
Metering		✓	✓
Water restrictions	✓		✓

Source: adapted from [www.toronto.ca](http://www.toronto.ca)

**Figure 27 Water conservation in Kenya**

There is loss of water in urban areas from leaks in pipes in need of repair. In informal settlements, pipes are often made from whatever materials are available and leak even more. Much of the supply in informal areas can easily be contaminated.

Great efforts are being made in Nairobi to reduce wastage. In Kibera, the largest informal settlement in Nairobi, new water storage tanks are being put in place. These prevent water from leaking away and keep the water clear of contamination by sewage.



Old water pipes crossing a sewage trench



New, safe water storage tank

Source: [www.environmental-expert.com](http://www.environmental-expert.com); [www.kwaho.org](http://www.kwaho.org)



## POTENTIAL NEW SOURCES OF WATER

In many parts of the world there is still the potential to build more dams and reservoirs, and there are aquifers that are as yet untapped. There are others ways of increasing water supply that have more potential: desalination and cloud seeding.

### Figure 28 Desalination of sea water

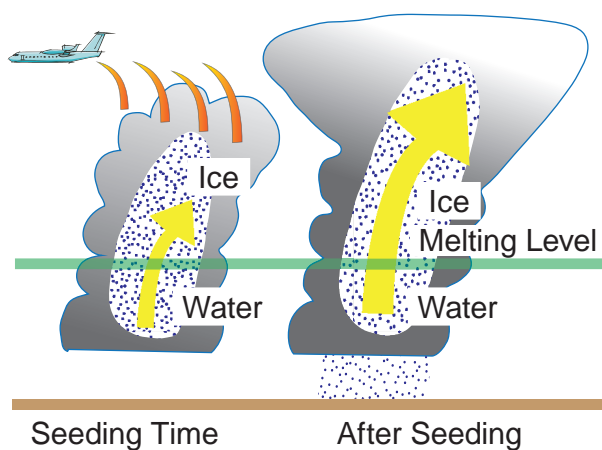
These plants are expensive to construct, but have the potential to produce plentiful supplies of water at reasonable cost in the long run. The 'eco-city' of Tianjin in China has part of its water supply from desalination.



A desalination plant

Source: ©Shao Weiwei/Shutterstock

### Figure 29 Cloud seeding



Many rain drops start their life as snow flakes which form around small particles in the air. If dry ice or silver iodide are dropped into clouds, they can create the condensation nuclei that are needed to generate rainfall, a process called cloud seeding.

This method works only if there are already clouds containing sufficient moisture. It encourages the clouds to form droplets heavy enough to fall as rain. It has been used mainly in the USA where there have been good results. It seems to work best in mid-latitudes.

There are concerns that the outcome of cloud seeding is unpredictable, inducing very intense precipitation.

In November 2009 there had been a prolonged drought over Beijing in China. In the hope of ending the drought, some clouds were seeded over the city. This produced very heavy snowfall over the city that was some of the earliest ever known in the city, and brought Beijing to a halt.

There are pressure groups in Kenya urging the government to do more and try cloud seeding when large parts of the country are experiencing drought.

Source: [www.aoml.noaa.gov](http://www.aoml.noaa.gov)

### Sources of information and copyright

- Figure 1 <http://www.toronto.ca/water/supply/index.htm>  
<http://store.eiu.com/product/article.aspx?productid=475217632>  
<http://www.mercer.com/press-releases/quality-of-living-report-2010>  
<http://www.shutterstock.com - 2240656>
- Figure 2 <http://www.unhabitat.org/content.asp?cid=4219&catid=254&typeid=13&subMenuId=0>  
<http://www.shutterstock.com - 1133294/21247697@N02/3092194631/in/photostream>
- Figure 3 [www.lboro.ac.uk/gawc/](http://www.lboro.ac.uk/gawc/)
- Figure 4 [file:///Volumes/G4%20W13%20USB/G4%202013%20a%20Winter/Resource...20World's%20fastest%20growing%20urban%20areas%20\(1\).webarchive](file:///Volumes/G4%20W13%20USB/G4%202013%20a%20Winter/Resource...20World's%20fastest%20growing%20urban%20areas%20(1).webarchive)
- Figure 5 [http://www.citymayors.com/sections/rankings\\_content.html](http://www.citymayors.com/sections/rankings_content.html)
- Figure 6 <http://store.eiu.com/article.aspx?productid=475217632.html>
- Figure 7 <http://www.toronto.ca/water/supply/index.htm>  
<http://buildipedia.com/operations/engineering-operations-news/toronto-s-deep-lake-water-cooling-system?print=1&tmpl=component>
- Figure 8 Don Valley – <http://www.trca.on.ca/dotAsset/55381.pdf>
- Figure 9 [http://siteresources.worldbank.org/EXTWAT/Resources/4602122-1210186345144/GWMATE\\_English\\_CP\\_13.pdf](http://siteresources.worldbank.org/EXTWAT/Resources/4602122-1210186345144/GWMATE_English_CP_13.pdf)  
<http://www.fredhoogervorst.com/photo/04361>
- Figure 10 <http://siteresources.worldbank.org/EXTWAT/Resources/4602122-1210186345144/GWMATE>
- Figure 11 [http://toronto-yyz.airports-guides.com/yyz\\_climate.html](http://toronto-yyz.airports-guides.com/yyz_climate.html)
- Figure 12 [http://www.toronto.ca/water/supply/supply\\_facilities/rcharris/pdf/water\\_filtration\\_process.pdf](http://www.toronto.ca/water/supply/supply_facilities/rcharris/pdf/water_filtration_process.pdf)
- Figure 13 <http://www.world66.com/africa/kenya/centralhighlands/nyeri/lib/climate>
- Figure 14 [http://siteresources.worldbank.org/INTWRD/Resources/GWMATE\\_English](http://siteresources.worldbank.org/INTWRD/Resources/GWMATE_English)
- Figure 15 [http://siteresources.worldbank.org/INTWRD/Resources/GWMATE\\_English\\_CP\\_13.pdf](http://siteresources.worldbank.org/INTWRD/Resources/GWMATE_English_CP_13.pdf)
- Figures 16 & 17 <http://www.toronto.ca/watereff/pdf/chap3.pdf>
- Figure 18 [http://www.weap21.org/downloads/GWC\\_Report\\_4.pdf](http://www.weap21.org/downloads/GWC_Report_4.pdf)
- Figure 19 [nairobi-chronicle.wordpress.com/2008/08/11/nairobi-water-shortages-to-get-worse/](http://nairobi-chronicle.wordpress.com/2008/08/11/nairobi-water-shortages-to-get-worse/)
- Figure 20 [http://www.ecfa.or.jp/japanese/act-pf\\_jka/H19/renkei/koei\\_nairobi.pdf](http://www.ecfa.or.jp/japanese/act-pf_jka/H19/renkei/koei_nairobi.pdf)

- Figure 21 <http://www.tiimes.ucar.edu/highlights/fy06/images/hydrological%20cycle.jpg>
- Figure 22 [www.ctahr.hawaii.edu/oc/freepubs/pdf/EN-106.pdf](http://www.ctahr.hawaii.edu/oc/freepubs/pdf/EN-106.pdf)
- Figure 24 [http://www.iisd.org/cristaltool/documents/IUCN\\_Kenya\\_Garissa\\_long.pdf](http://www.iisd.org/cristaltool/documents/IUCN_Kenya_Garissa_long.pdf)
- Figure 25 [http://cccsn.ca/documents/Climate\\_Variability\\_and\\_Change\\_en.pdf](http://cccsn.ca/documents/Climate_Variability_and_Change_en.pdf)
- Figure 26 <http://www.toronto.ca/watereff/chap4/pdf>
- Figure 27 <http://www.environmental-expert.com/Files%5C0%5Carticles%5C20194%5Cwaterproject.pdf>  
<http://www.kwaho.org/pd-watercan-kibera.html>
- Figure 28 <http://www.shutterstock.com15511054>
- Figure 29 [http://www.aoml.noaa.gov/hrd/hrd\\_sub/cseed.html](http://www.aoml.noaa.gov/hrd/hrd_sub/cseed.html)