



GCE A level

1204/01

GEOGRAPHY - G4
G4 - SUSTAINABILITY

A.M. FRIDAY, 17 June 2011

1³/₄ hours

ADDITIONAL MATERIALS

In addition to this question paper, you will need a 12 page answer book and the Resource Folder.

INSTRUCTIONS TO CANDIDATES

Use black ink or ball-point pen.

Answer **all** questions.

Write your answers in the separate answer book provided.

Write your name, centre number and candidate number in the spaces at the top of the answer book.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication used in your answers.

You are reminded that this paper is synoptic and so will assess your ability to draw on your understanding of the connections between the different aspects of the subject represented in the geography specification.

SECTION A

Answer all questions.

*In this section you may use information from the **Resource Folder** and your own research.*

1. Describe and suggest reasons for variations in food consumption between countries. [10]
(approximately 13 minutes)

2. For **one or more** countries, explain how economic and technological factors may hinder food production. [10]
(approximately 13 minutes)

3. Outline ways in which physical factors influence water supply in **one or more** countries or areas. [10]
(approximately 13 minutes)

4. ‘Managing water supplies sustainably presents many challenges.’
Discuss with reference to Bolivia and/or any other area. [25]
(approximately 33 minutes)

SECTION B

In this section you may use information from any of your studies for G4 and from other studies in Geography.

5. Describe ways in which transport and communications are changing in cities.
To what extent are the changes sustainable? [25]
(approximately 33 minutes)



GCE A level

1204/01-A

**GEOGRAPHY - G4
SUSTAINABILITY**

A.M. FRIDAY, 17 June 2011

**Examination copy.
To be given out at the start of the examination.
The pre-release copy must not be used.**

RESOURCE FOLDER

ADVICE TO CANDIDATES

Copies of the Pre-Release Resource Folder, issued in March 2011, may not be taken into the examination.

The Folder contains information about water supply and food production in Bolivia. It examines threats to the water supplies and difficulties encountered in the country's agriculture. Plans to boost water supplies and stimulate agricultural output are also presented.

BLANK PAGE

Contents

Page

BACKGROUND TO BOLIVIA

Figure 1	Introduction to Bolivia	4
Figure 2	Relief regions of Bolivia	5
Figure 3	Regions of Bolivia	5
Figure 4	Indicators for Bolivia and selected countries	6
Figure 5	Rate of natural increase and daily calorie intake for selected countries	6
Figure 6	Water usage in selected countries	7
Figure 7	Water sources in selected countries	7

WATER SUPPLY

Figure 8	Water supply to La Paz	8
Figure 9	Annual average temperature and rainfall for La Paz	8
Figure 10	Building over the canyon in La Paz	8
Figure 11	Main areas within La Paz	8
Figure 12	Threats to water supply in La Paz	9
Figure 13	Precipitation distribution in Bolivia	10

FOOD SUPPLY

Figure 14	Farming in Bolivia	11
Figure 15	Food security – areas of high and medium risk of food shortage	12
Figure 16	Food shortages in Bolivia	12
Figure 17	Irrigated areas of Bolivia	13
Figure 18	Irrigation and food production in Bolivia	13
Figure 19	An irrigation channel in Bolivia	13
Figure 20	The potential for irrigation in Bolivia	14
Figure 21	The role of aid in Bolivia	14
Figure 22	Other potential agricultural developments in Bolivia	15
Figure 23	Agricultural improvement programmes in Bolivia	15
	Sources of information	16

BACKGROUND TO BOLIVIA

Figure 1 Introduction to Bolivia

Bolivia is a landlocked country in South America.



(2010 estimates)	Bolivia	UK
Population	9 775 246	61 113 205
Land area (km ²)	1 098 581	241 610
Water area (km ²)	15 280	1 680

There are several quite distinct regions. The largest region is rainforest in the north of the country. This is part of the Amazon Basin. This area has been developed very little and the population of the area is very low.

Much of the west of the country is part of the Andes mountain chain. Parts are over 6 500 metres and much of this area is either too high or too steep for very much settlement.

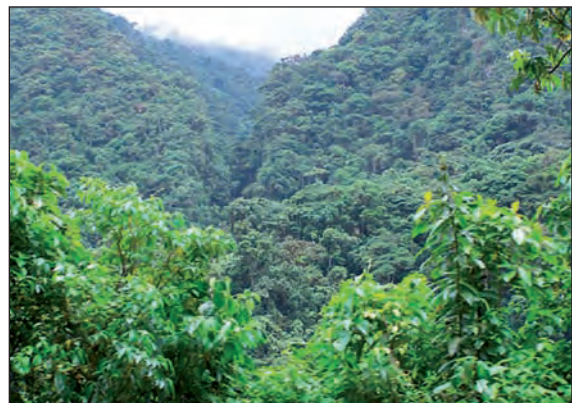
The Eastern lowlands are mainly grasslands. They are used for agriculture, but have the potential to be used much more intensively.

Most of the population live in valleys or on lower slopes to the eastern side of the Andes. These areas themselves vary in character. Between the Andes and the Amazon Basin is a transition zone, the Yungas. The Andes themselves are divided into two regions. To the west, the high peaks are in an area known as the Altiplano. In the east are many deep valleys cut into the mountains, the Andean Valleys.

The main cities are in the Altiplano, Yungas and Andean Valleys. They are La Paz (1.71 million) which is the capital, Santa Cruz (1.58 million), Cochabamba (940 000) and Sucre (270 000).



La Paz



Rainforest

Source: after www.cia.gov and countrystudies.us

Figure 2 Relief regions of Bolivia



Source: www.worldatlas.com

Figure 3 Regions of Bolivia



Source: www.southwindadventures.com

Figure 4 Indicators for Bolivia and selected countries (2010 available data)

	Argentina	Bolivia	Kenya	USA	Vietnam
Average daily calorie intake	3 004	2 175	2 039	3 825	2 650
Protein g/day	93	56	57	116	67
Food aid/capita kg	0	6.9	9.0	0	1.0
Water usage per person m ³ /day	753	157	46	1 600	847
Irrigated land km ²	15 500	1 320	1 030	223 850	30 000
Total population millions	40.9	9.78	39.0	307.2	85.9
Natural increase per thousand	10.5	18.8	26.9	5.4	10.1
Total fertility rate per woman	2.4	3.2	4.6	2.1	1.8
Life expectancy years	76.6	66.9	57.9	78.1	71.6
Literacy rate %	97.2	86.7	85.1	99.2	90.3
GDP/capita US\$	14 200	4 500	1 600	47 500	2 800
HDI (Rank)	0.87 (49th)	0.74 (113th)	0.54 (147th)	0.96 (13th)	0.73 (116th)
% in primary employment	1	40	75	<1	55

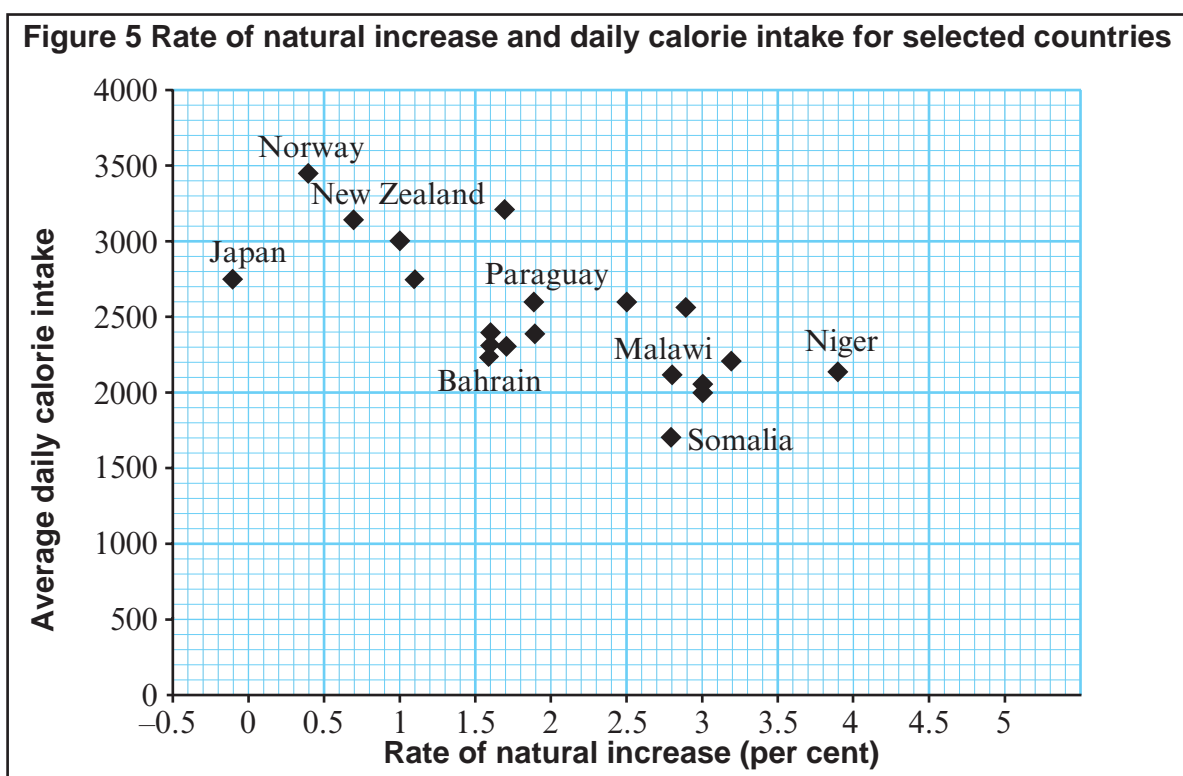
Source: www.cia.govSource: www.cia.gov&faostat.fao.org

Figure 6 Water usage (%) in selected countries

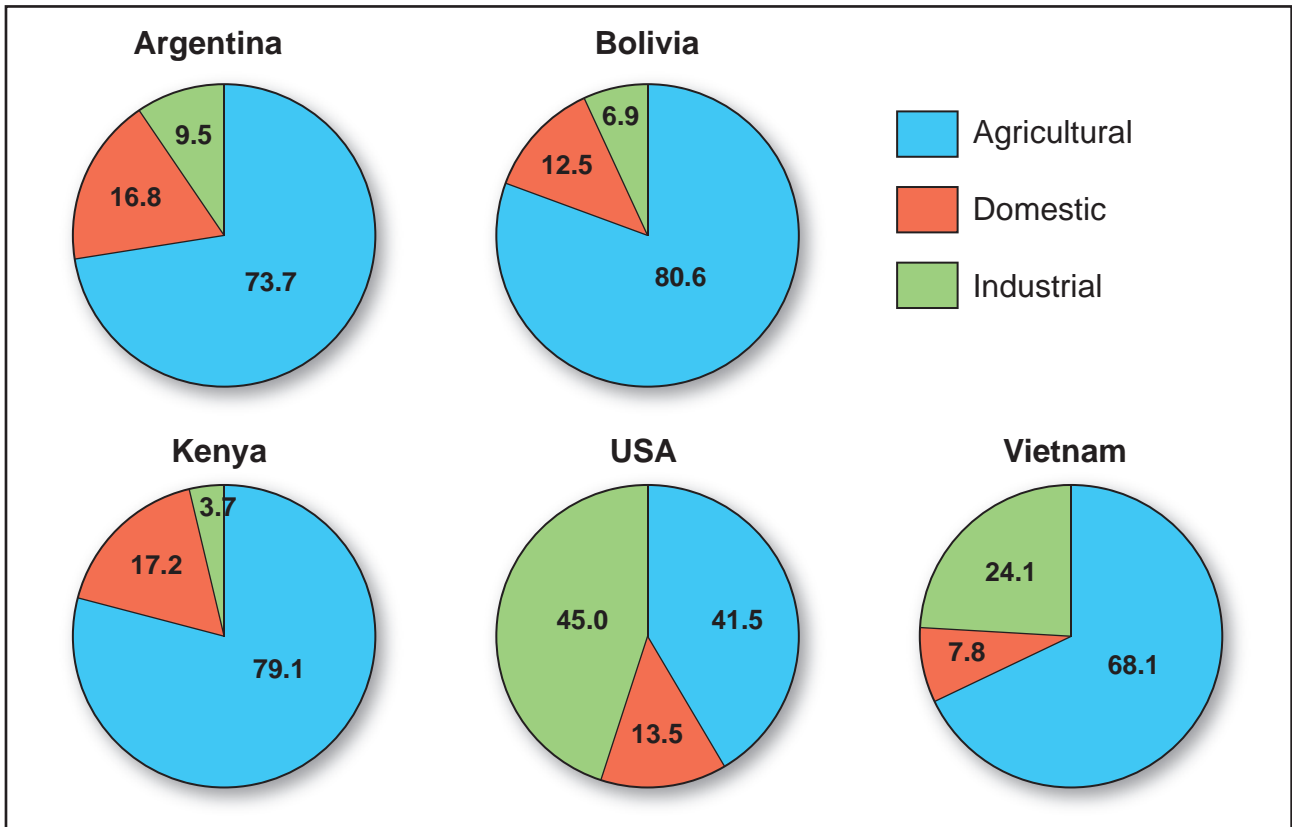
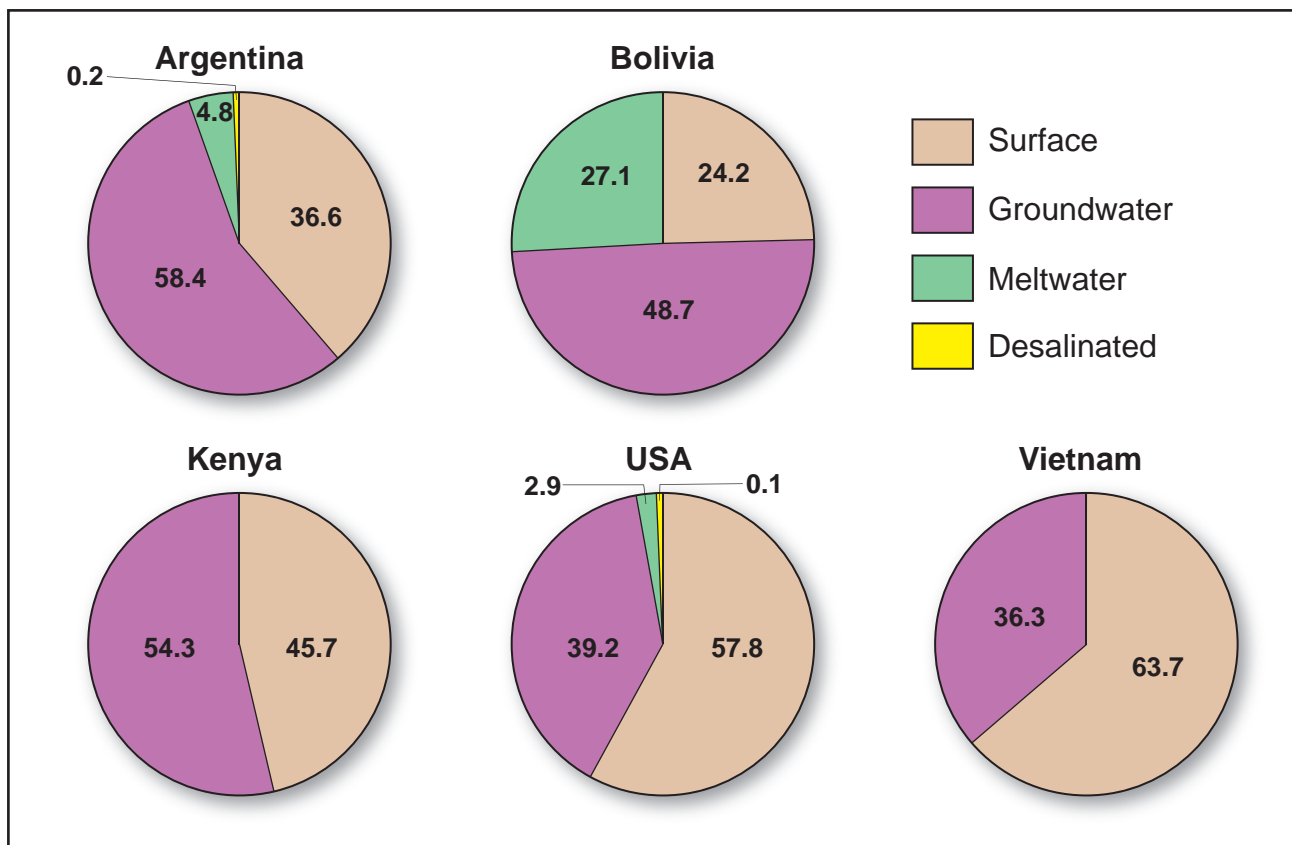


Figure 7 Water sources (%) in selected countries



Source: www.fao.org/nr/water/aquastat

WATER SUPPLY

Figure 8 Water supply to La Paz

La Paz has a relatively low rainfall of 525mm annually compared to most of the UK. For example, London receives 755mm and Cardiff 1065mm. Temperatures are similar to those within the UK, so rapid evaporation is not a great problem.

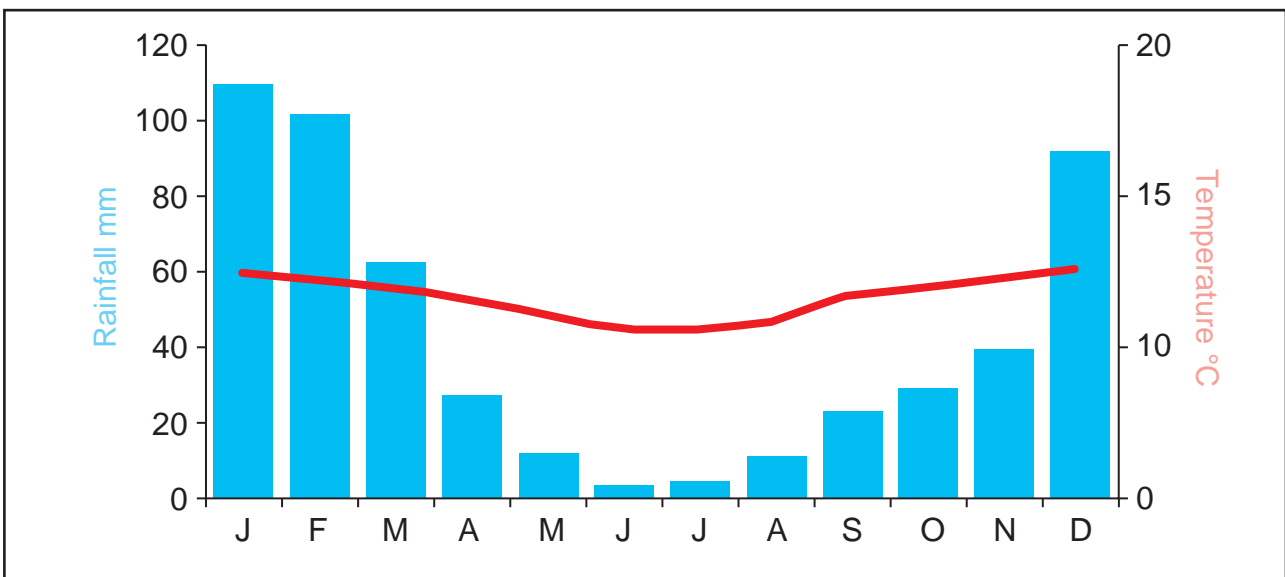
The main problem with the rainfall is that in the four months from May to August, on average, only 20mm fall. During the dry spell, La Paz relies on meltwater from glaciers and snow melt from nearby high peaks in the Andes.

The central part of La Paz has been built in a valley created by the Choqueyapu River, which is contained in a canyon through most of the city. The canyon has been covered throughout most of the city, so there are few places where the river is visible.

Water can be extracted from the Choqueyapu River in the El Centro region of the city. Pipelines carry water from El Centro to Zona Sur area, but there is little access to water in the rapidly-growing El Alto area of the city.

Source: www.maclester.edu

Figure 9 Annual average temperature and rainfall for La Paz



Source: www.climatetemp.info

Figure 10 Building over the canyon in La Paz

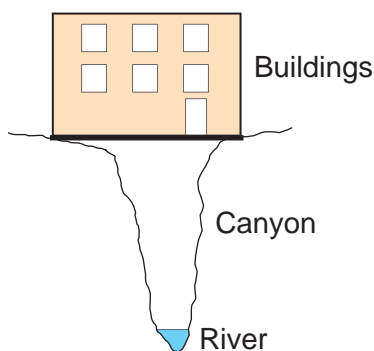


Figure 11 Main areas within La Paz

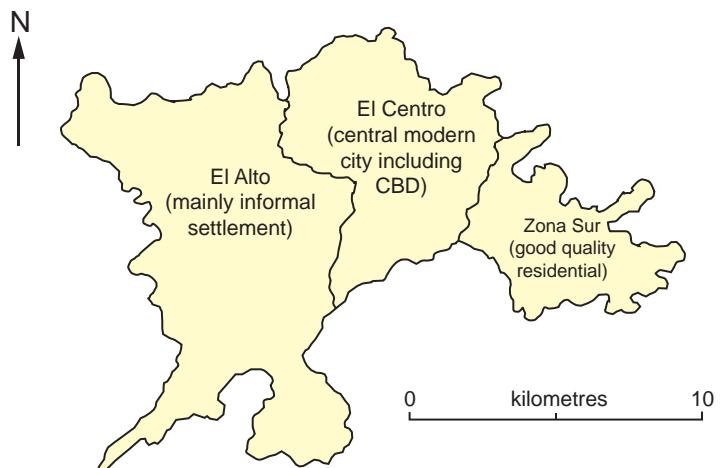
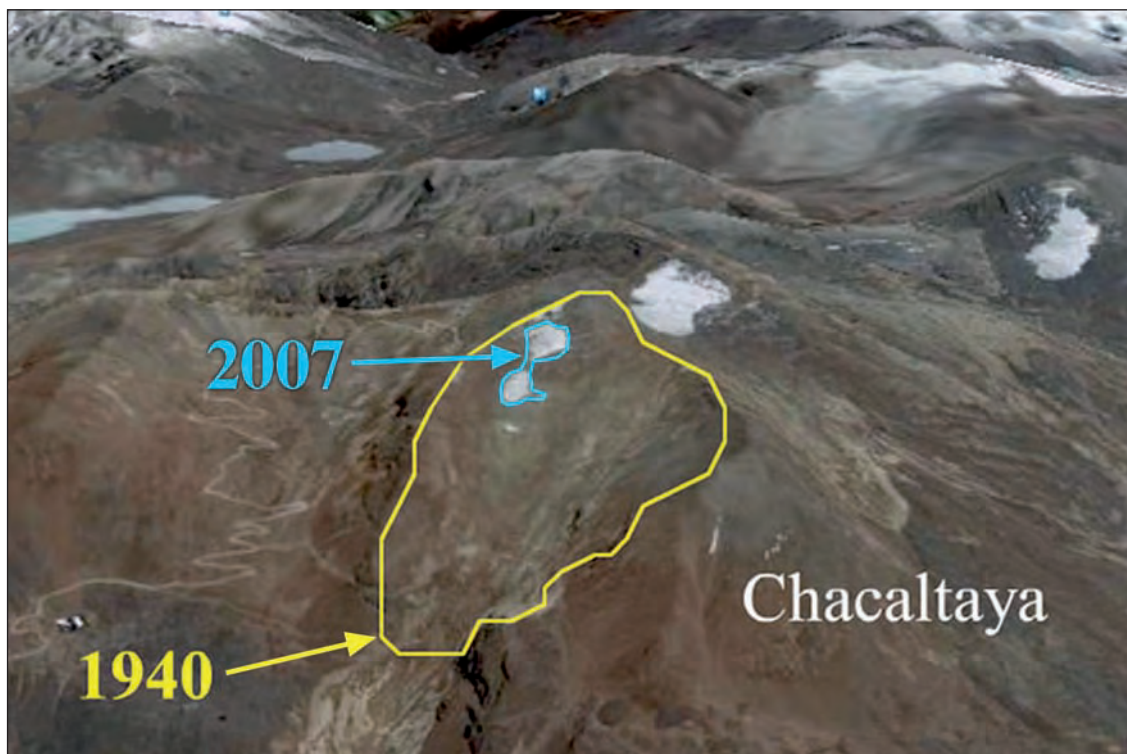


Figure 12 Threats to water supply in La Paz

Climate change is already having an impact on water supplies to La Paz. Precipitation in many parts of the Andes has declined considerably. This means that there is less run off of water from lower slopes, and less water from melting snow and glaciers from higher altitudes.

One glacier and snowfield which has helped provide water to La Paz is on the mountain Chacaltaya. The photograph shows the extent of the glacier in 1940 and 2007. It is at an altitude of 5 300m and once had the highest ski resort in the world. In 2005 the University of San Andres in La Paz was predicting that the Chacaltaya glacier would disappear by 2015. This actually happened in 2009. The difficulty is not that just one source of meltwater has gone, but that almost all sources that supply La Paz have done so.

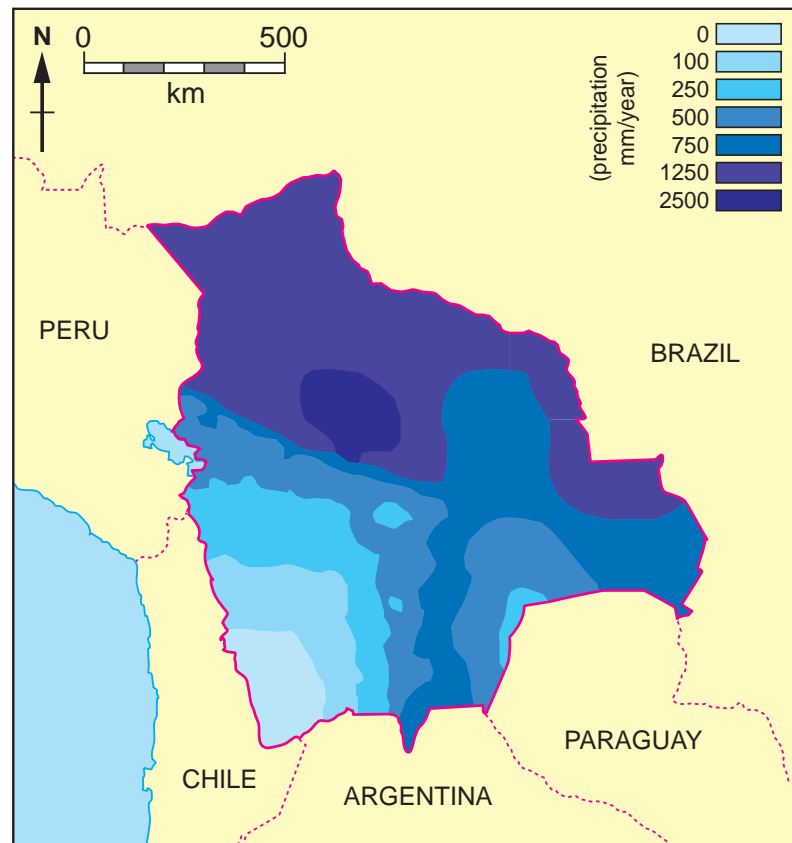


There is still meltwater coming from ice on the multiple peaks of Illimani which is also near to La Paz. Between Illimani and La Paz are many villages, such as Khapi. The villagers depend on meltwater to irrigate their crops of potatoes, maize and beans. But in recent years the flow has been reduced, and often the water that does flow is discoloured — there is just not enough water to disperse impurities.

One response to the deteriorating conditions has been for villagers to leave the village and move to La Paz. In the last 10 years 15 families have left Khapi leaving only 45 families remaining. The only area they can afford to move to in La Paz is El Alto. Ironically this part of the city has the least water available of any. What water there is in this district is almost always contaminated with sewage.

Water supplies are not just a problem in La Paz. To the south-east, in the city of Cochabamba, water supplies were privatised in 1999. As a result, families earning US\$80 per month were having to pay out US\$20 for water. In 2000 there were a series of so-called 'water wars' in the city. As a result, the privatisation was reversed. This initially helped to reduce the cost of water, but did nothing to increase supplies.

Source: *news.bbc.co.uk*

Figure 13 Precipitation distribution in Bolivia

Most of the main cities of Bolivia are located in the Altiplano and Andean Valley regions. It is only in these parts of Bolivia that precipitation is low. Located on high, flatter areas within the Andes, they are in a rain shadow. The rain-bearing winds of Bolivia blow from the north-east where the air mass picks up large amounts of moisture over the warm Atlantic Ocean. The north-easterlies first cross the Amazon Basin where much of the moisture falls. Then the air is forced up the eastern slopes of the Andes in the Yungas region. Relief rainfall results, so there is little moisture remaining by the time the north-easterly winds reach the Altiplano and Andean Valleys. Between May and August the north-easterly winds migrate northwards hardly reaching the mountains, so very little moisture is brought to the area at that time.

Few people live in the Amazon rainforest, but for the few who do there is plentiful rainfall throughout the year. Located to the north of the country, the rainforest is still in the zone reached by the north-easterly winds, even when this wind belt as a whole migrates northwards.

To the east of the country, and to the south of the rainforests, are the Eastern Lowlands. Rainfall here is generally lower than in the Amazon Basin, but is adequate for the low numbers of people who live in the area. Once again it is the north-easterly winds that carry moisture to the area bringing plentiful rain between September and April. From May to August, south-easterly winds move into this part of the country. These winds carry little moisture in them creating a dry season.

The extreme south-western parts of the Andes receive hardly any rain and can be considered as highland areas of the Atacama Desert.

In Bolivia, the relationship between population density and precipitation is inverse.

FOOD SUPPLY

Figure 14 Farming in Bolivia

Approximately one third of the population of Bolivia is engaged in agriculture. The nature of the farming varies greatly from region to region. Most Bolivians have enough to eat most of the time, but food security is not certain.

Altiplano and Andean Valleys

- 60% of Bolivian farmers
- Farmers just beyond the subsistence level
- Provide for a basic family diet and 30% sold
- Work done by hand plus limited use of animal power
- Potatoes, maize, beans and quinoa
- Sheep, llamas and alpaca provide milk, meat and fibres
- Plots between one and three hectares
- Crops are grown on terraces on steep slopes
- Soil erosion and over-grazing can be problems



Terraces in Altiplano

Source: Shutterstock.com



Coffee growing in Yungas

Source: UN office on Drugs and Crime

Yungas

- 20% of Bolivian farmers
- Mostly fertile, holdings between 5 and 10 hectares
- More commercial, but mechanisation limited
- Maize and wheat on higher ground, coffee lower down
- Coca (source of cocaine) grown, crop often destroyed by government, need to deal with violent criminals
- Sugar cane and tropical fruits on the lower slopes

Amazonian Rainforest

- 5% of Bolivian farmers
- Not as developed as in Brazil
- Logging, cattle rearing and rice growing
- Farms between 50 and 75 hectares
- Commercial enterprises for export



Logging in the Rainforest

Eastern Lowlands

- Farms of up to 5 000 hectares exist
- Soya beans, rice, maize and coffee
- Drier areas have sheep and cattle
- All the farms commercial with some research and development
- Much specialised equipment
- Food sent to cities in Bolivia and export market

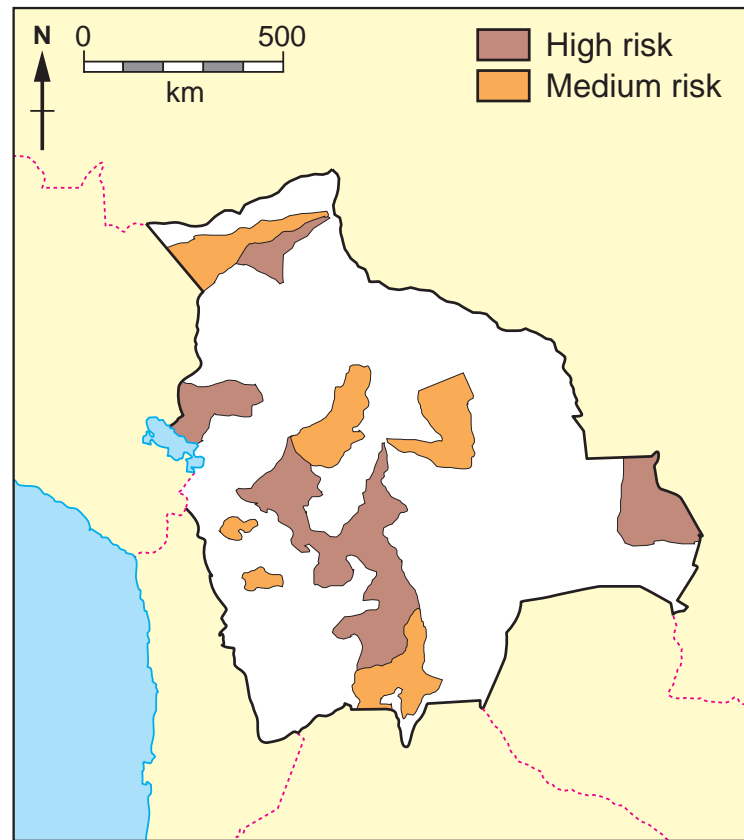


Sheep in Eastern Lowlands

Source: research.cip.cgiar.org

Turn over.

Figure 15 Food security – areas of high and medium risk of food shortage



Source: www.fhi.net

Figure 16 Food shortages in Bolivia

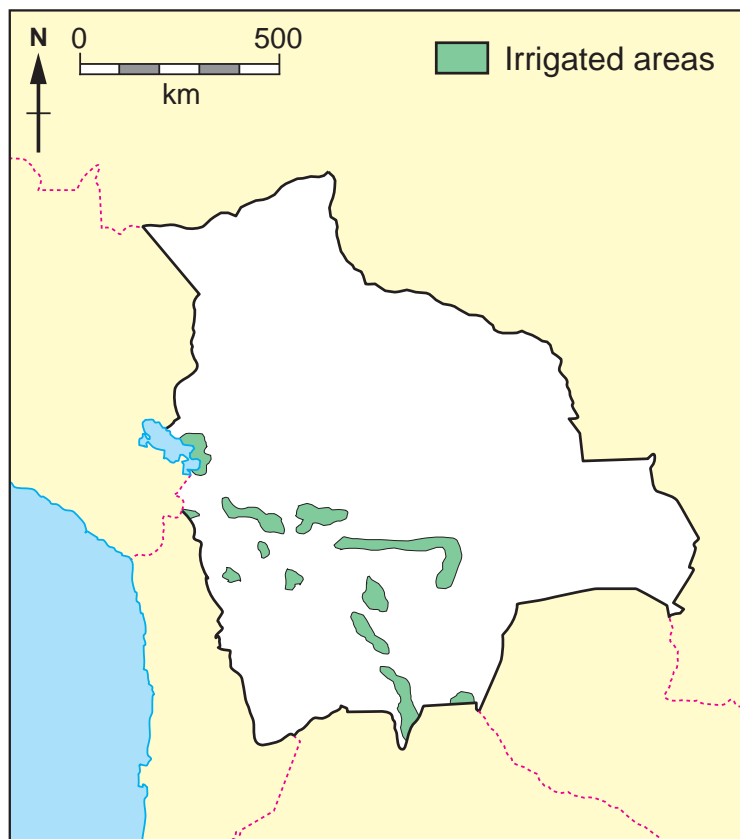
Food shortages occur in Bolivia for two main reasons. In the Altiplano there are frequent droughts, but in many of the lowland areas, flooding is a major threat.

Both the droughts and the flooding have a common cause, that is, the El Niño southern oscillation. This is a warming of the eastern Pacific Ocean off the west coast of South America that occurs every seven years or so. It has an impact on the weather throughout the world but is most pronounced in countries close to the warming.

The warming intensifies tropical storms so that they are more severe with heavier rainfall. The warming also alters pressure patterns so that the routes followed by some rain bearing systems are diverted so that they do not reach some areas normally in their path.

Bolivia normally imports only a small amount of wheat into the country in order to ensure an adequate diet for most of the population. When droughts or floods occur, food does need to be imported to replace food that is lost. This is often shipped into the country as aid. It is difficult to respond quickly with food aid for Bolivia. Being landlocked, there is no port for shipping to use. To the whole of the west of the country, the Andes form a very high barrier with only a few, very difficult roads. To the north and north-east is the huge Amazon Basin, which also has only a few difficult route-ways. To the south and south-east, there are huge distances across Argentina or Paraguay to cross before reaching points accessible to the outside world. Transport is expensive and improving it would be a strain on the Bolivian economy.

Source: www.bolivia.usaid.gov

Figure 17 Irrigated areas of Bolivia

Source: www.geo.uni-frankfurt.de

Figure 18 Irrigation and food production in Bolivia

Most of the irrigation in Bolivia is located in the Altiplano and Andean Valleys. Around 222 000 hectares are irrigated in the country, which only amounts to about 4% of the cultivated land. Most of these irrigated areas are around the cities of Cochabamba (82 000 hectares) and La Paz (36 000 hectares).

The majority of the irrigation systems are just sets of canals that divert rainfall into the fields where crops are growing. Only a very small number of these have dams to catch and retain rainfall. As a result, the irrigation systems dry up when they are most needed when rainfall is limited.

Because there is little control over the flow of irrigation water, when rainfall is occasionally heavy, it can lead to soil erosion in the fields that are being irrigated. Uncontrolled irrigation is the main cause of soil erosion in Bolivia.

During times when there is little rainfall, such simple irrigation systems can cause salinity levels in the soil to rise. It is estimated that about 17% of the irrigated land has become too saline to grow crops, and where they can still be grown, yields have become severely reduced.

Source: ftp.fao.org

Figure 19 An irrigation channel in Bolivia

Source: www.betterbytheyear.org
© Saskia Fokkink/International Service

Figure 20 The potential for irrigation in Bolivia

As rainfall is low where most people live in Bolivia, and droughts are common, one solution is to build dams to supply urban populations with water, but more importantly, to supply water for irrigation. Many of the valleys in the Andes are steep sided and long, often being fairly narrow, so that the construction of dams could retain considerable amounts of water.

One of the main reasons that Bolivia has not undertaken building large dams in the past has been a lack of capital to invest in such construction. Towards the end of 2009 the Inter-American Development Bank (IDB) approved a loan of US\$106 million to complete the construction of a dam across the Misicuni River near to the city of Cochabamba.

This scheme will not only increase water available for irrigation but will help to increase the supply of fresh water to Cochabamba and La Paz. In addition, the scheme will generate 80 MW of electricity.

In approving the loan the president of the IDB said, "Through this project, Bolivia is showing that when water is sustainably managed, it can become a strategic resource that generates improved human health, increased food production and greater access to clean, renewable energy."

Part of the loan will be used to reduce soil erosion, enhance water management, and protect priority habitats in the areas of the watershed most exposed to such risks.

Source: www.fao.org



Construction work on the Misicuni Dam

Figure 21 The role of aid in Bolivia

Food production and farmers' incomes in Bolivia have both increased as a result of overseas aid in Bolivia. The charity USAID has helped to finance the building of micro-irrigation projects that conserve water efficiently and direct it towards where it is needed.

Donated money is used in a number of ways. Other infrastructure has been improved. For example, roads have been given proper surfacing so that transporting food to local markets is easier and faster than it has been in the past.

In addition, money has been spent on the introduction of basic IT equipment. This has helped in several ways. For example, agricultural trainers can spread correct cultivation methods, often by such simple means as putting photographs of good practice on-line. IT also allows farmers to know current prices and which local markets are in need of the produce they have available. It generally enables them to market their food more effectively and profitably.

In times of food shortages this has allowed stocks to be moved from areas where there is a surplus to regions where supplies have been running low.

Source: www.usaid.gov

Figure 22 Other potential agricultural developments in Bolivia

Any development for agriculture is not without risk.

The greatest potential for increasing food production in Bolivia is to develop the rainforest areas. To increase food supplies for the people of Bolivia would involve adopting methods at the cutting edge of current research. The Bolivian government would struggle to fund this research. Opportunities to receive overseas funding for this are limited too.

In order to bring about economic development for the country so that all additional food needs could be imported, it would make sense to clear the native forest and plant oil palm, grow soya beans or adopt other commercial farming. This presents Bolivia with a dilemma. It holds a great deal of untouched rainforest. Rainforest covers 54% of the country and half of this is completely natural. This is not a result of intentional conservation. As the government is based in the Andes, the rainforest has been neglected. In addition, parts of the national debts have been written off in exchange for creating forest reserves. Maintaining rainforest is important globally, but further payments to Bolivia to keep the reserves intact are unlikely.

The greatest loss of rainforest occurred in 2005 when a small area being burnt to create a small patch of land for agriculture got out of control and half a million hectares were destroyed (1.7% of the natural forest).

Source: www.worldfoodprize.org



Rainforest burning

Source: *Ricardo Funari*



An oil palm plantation

Source: © *Achmad Rabin Taim*

Figure 23 Agricultural improvement programmes in Bolivia

Two programmes that appear promising in helping other areas of Bolivia are:

1 Strategies for International Development (SID)

One of its recent projects was helping farmers reclaim and transform parched land into productive pastures. In limited trials so far farmers have, on average, increased their income from US\$320 a year to US\$600 a year. The goal is to raise the income to US\$900 a year, but the community needs more money and training. However, it is very challenging to find additional funding.

2 Small Farmers Technical Assistance Service Project (PROSAT)

This has been paid for by the International Fund for Agricultural Development, and is a six-year World Bank pilot project to strengthen rural communities through technical assistance. The aim is to target 206 000 poor rural families, but only a fraction of this number has been helped so far. The total estimated cost will be US\$28.3 million. Being a project sponsored by the World Bank, it is likely that this funding will be provided. So far, in limited trials, potato yields have increased by 2.5 tonnes per hectare and have increased food security in the small areas where trials are under way.

Source: www.ifad.gov

Turn over.

Sources of information

- Figure 1 <https://www.cia.gov/library/publications/the-world-factbook/geos/bl.html> & <http://countrystudies.us/bolivia/>
- Figure 2 <http://www.worldatlas.com/webimage/countrys/samerica/lgcolor/bocolor.htm>
- Figure 3 <http://www.southwindadventures.com/map-bol.htm>
- Figure 4 <http://www.cia.gov/library/publications/the-world-factbook/>
- Figure 5 <https://www.cia.gov/library/publications/the-world-factbook/> & <http://faostat.fao.org/site/368/default.asp#ancor>
- Figures 6 & 7 <ftp://faostat.fao.org/agl/aglw/aquastat/GMIAv401hires.pdf>
- Figure 8 <http://www.macalester.edu/courses/geog61/amartin/elalto.html>
- Figure 9 <http://www.climatetemp.info/bolivia/la-paz.html>
- Figure 12 <http://news.bbc.co.uk/1/hi/sci/tech/8394324.stm>
- Figure 13 http://www.bestcountryreports.com/Precipitation_Map_Bolivia.html
- Figure 14 https://research.cip.cgiar.org/confluence/download/attachments/13021/Bolivia_Feb_2006.pdf
- Figure 14 *Shutterstock.com UN office on Drugs and Crime*
- Figure 15 <http://www.fhi.net/fhibolivia/challenge.htm>
- Figure 16 <http://bolivia.usaid.gov/US/6Fs.htm>
- Figure 17 http://www.geo.uni-frankfurt.de/ipg/ag/dl/f_publicationen/1999/doell_siebert_kwws1.pdf
- Figure 18 <http://www.fao.org/nr/water/aquastat/countries/bolivia/indexesp.stm>
- Figure 19 <http://www.betterbytheyear.org/bolivia/gallery/image13.htm>
© Saskia Fokkin/International Service
- Figure 20 <http://www.fao.org/countryprofiles/index.asp?lang=en&ISO3-bol&subj=4>
- Figure 21 <http://www.usaid.gov/pubs/cbj2002/lac/bo/511-002.html>
- Figure 22 <http://worldfoodprize.org/assets/YouthInstitute/06proceedings/DavenportCentralHS.pdf>
Ricardo Funari © Achmad Rabin Taim
- Figure 23 http://www.ifad.org/evaluation/public_html/eksyst/doc/country/pl/bolivia/bo.htm



GCE A level

1204/01-B

**GEOGRAPHY - G4
SUSTAINABILITY**

(Suitable for Modified Language Candidates)

**Pre-Release Material for examination
on 17 June 2011.**

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 Folder contains information about water supply and food production in Bolivia. It examines threats to the water supplies and difficulties encountered in the country's agriculture. Plans to boost water supplies and stimulate agricultural output are also presented.

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 at 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 rewarded in answers. 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. Many are only extracts or shortened versions of fuller documents. Some lengthy sources may have been adapted by extensive re-writing to condense them. It is well worth following these links for greater depth of reading and for more recent updates of material.

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.

Contents

	Page
BACKGROUND TO BOLIVIA	
Figure 1	Introduction to Bolivia 4
Figure 2	Relief regions of Bolivia 5
Figure 3	Regions of Bolivia 5
Figure 4	Indicators for Bolivia and selected countries 6
Figure 5	Rate of natural increase and daily calorie intake for selected countries 6
Figure 6	Water usage in selected countries 7
Figure 7	Water sources in selected countries 7
WATER SUPPLY	
Figure 8	Water supply to La Paz 8
Figure 9	Annual average temperature and rainfall for La Paz 8
Figure 10	Building over the canyon in La Paz 8
Figure 11	Main areas within La Paz 8
Figure 12	Threats to water supply in La Paz 9
Figure 13	Precipitation distribution in Bolivia 10
FOOD SUPPLY	
Figure 14	Farming in Bolivia 11
Figure 15	Food security – areas of high and medium risk of food shortage 12
Figure 16	Food shortages in Bolivia 12
Figure 17	Irrigated areas of Bolivia 13
Figure 18	Irrigation and food production in Bolivia 13
Figure 19	An irrigation channel in Bolivia 13
Figure 20	The potential for irrigation in Bolivia 14
Figure 21	The role of aid in Bolivia 14
Figure 22	Other potential agricultural developments in Bolivia 15
Figure 23	Agricultural improvement programmes in Bolivia 15
Sources of information	16

BACKGROUND TO BOLIVIA

Figure 1 Introduction to Bolivia

Bolivia is a landlocked country in South America.



(2010 estimates)	Bolivia	UK
Population	9 775 246	61 113 205
Land area (km ²)	1 098 581	241 610
Water area (km ²)	15 280	1 680

There are several quite distinct (different) regions. The largest region is rainforest in the north of the country. This is part of the Amazon Basin. This area has been developed very little. The population of the area is very low.

Much of the west of the country is part of the Andes mountain chain. Parts are over 6 500 metres and much of this area is either too high or too steep for very much settlement.

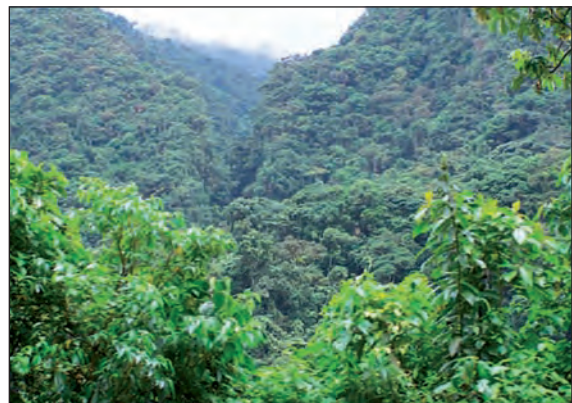
The Eastern lowlands are mainly grasslands. They are used for agriculture, but could be used much more intensively.

Most of the population live in valleys or on lower slopes to the eastern side of the Andes. These areas themselves vary in character. Between the Andes and the Amazon Basin is a transition zone, the Yungas. The Andes are divided into two regions. To the west, the high peaks are in an area known as the Altiplano. In the east are many deep valleys called the Andean Valleys cut into the mountains.

The main cities are in the Altiplano, Yungas and Andean Valleys. They are La Paz (1.71 million) which is the capital, Santa Cruz (1.58 million), Cochabamba (940 000) and Sucre (270 000).



La Paz



Rainforest

Figure 2 Relief regions of Bolivia



Source: www.worldatlas.com

Figure 3 Regions of Bolivia



Source: www.southwindadventures.com

Figure 4 Indicators for Bolivia and selected countries (2010 available data)

	Argentina	Bolivia	Kenya	USA	Vietnam
Average daily calorie intake	3 004	2 175	2 039	3 825	2 650
Protein g/day	93	56	57	116	67
Food aid/capita kg	0	6.9	9.0	0	1.0
Water usage per person m ³ /day	753	157	46	1 600	847
Irrigated land km ²	15 500	1 320	1 030	223 850	30 000
Total population millions	40.9	9.78	39.0	307.2	85.9
Natural increase per thousand	10.5	18.8	26.9	5.4	10.1
Total fertility rate per woman	2.4	3.2	4.6	2.1	1.8
Life expectancy years	76.6	66.9	57.9	78.1	71.6
Literacy rate %	97.2	86.7	85.1	99.2	90.3
GDP/capita US\$	14 200	4 500	1 600	47 500	2 800
HDI (Rank)	0.87 (49th)	0.74 (113th)	0.54 (147th)	0.96 (13th)	0.73 (116th)
% in primary employment	1	40	75	<1	55

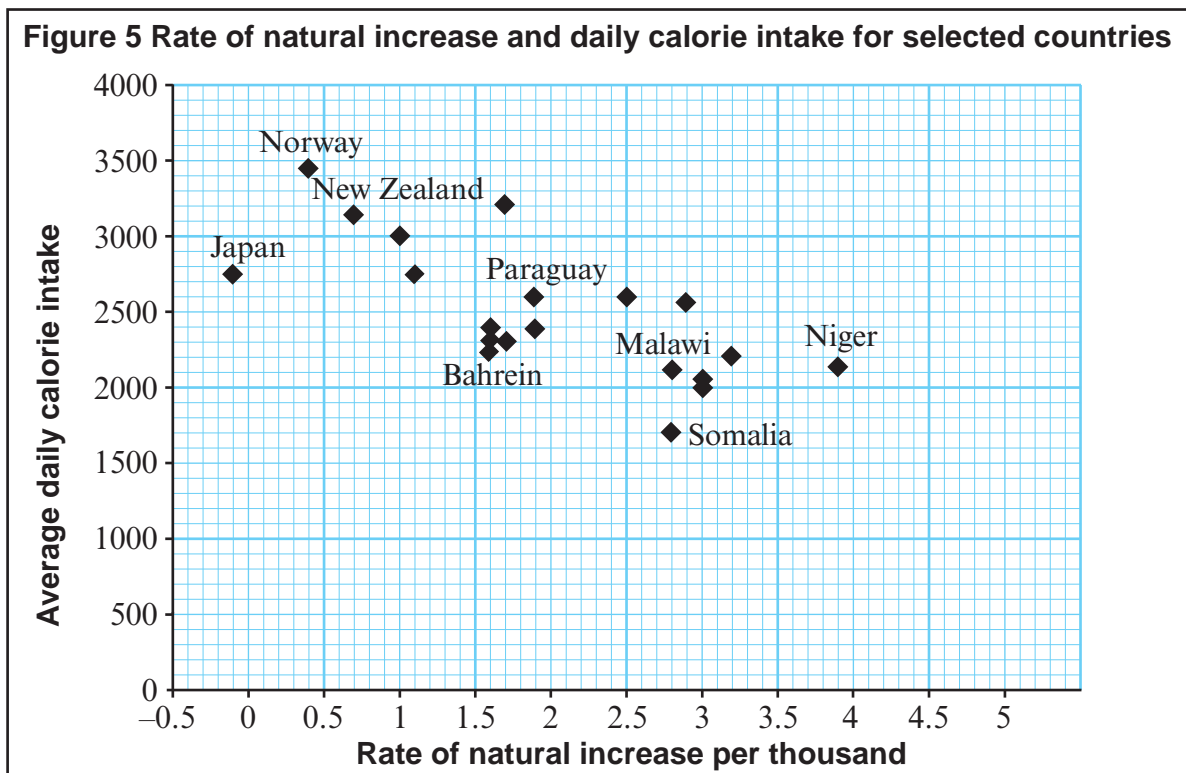
Source: www.cia.govSource: www.cia.gov&faostat.fao.org

Figure 6 Water usage (%) in selected countries

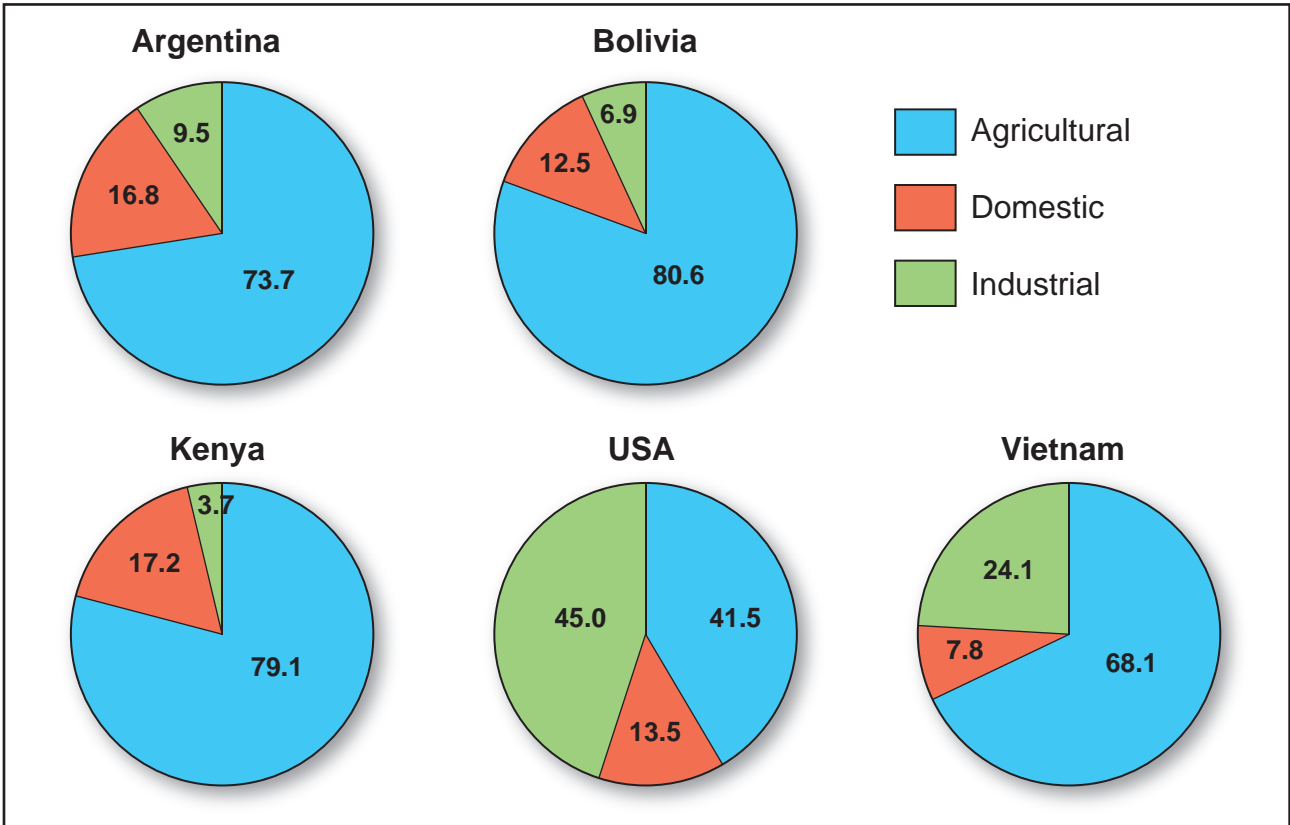
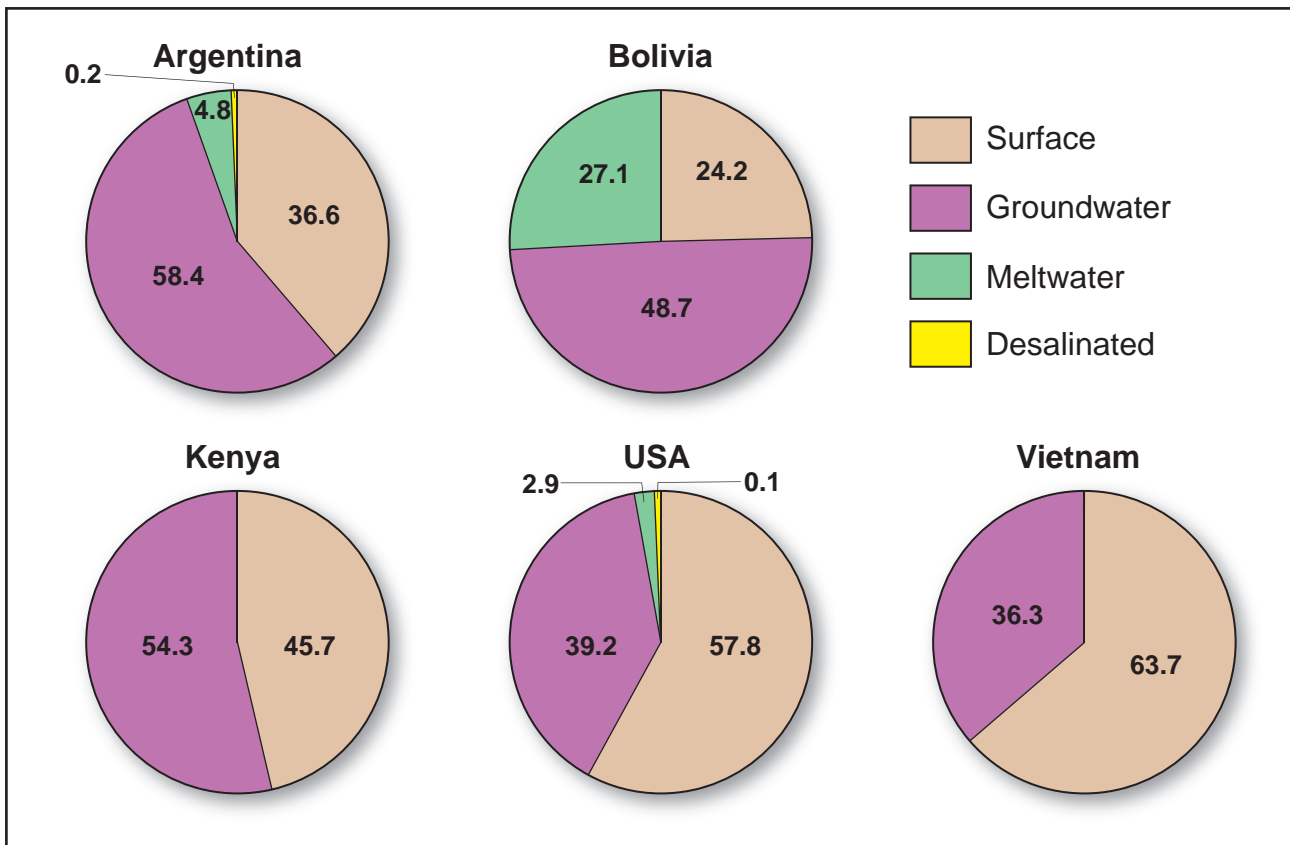


Figure 7 Water sources (%) in selected countries



Source: www.fao.org/nr/water/aquastat

WATER SUPPLY

Figure 8 Water supply to La Paz

La Paz has a relatively low rainfall of 525mm annually compared to most of the UK. For example, London receives 755mm and Cardiff 1065mm. Temperatures are similar to those within the UK, so rapid evaporation is not a great problem.

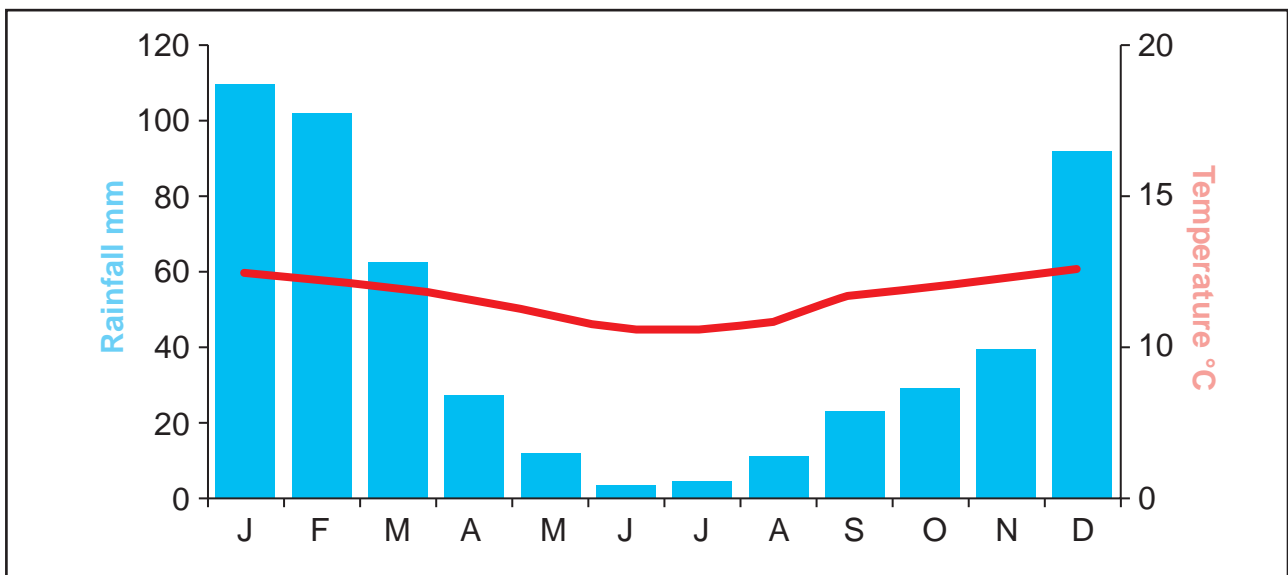
The main problem with the rainfall is that in the four months from May to August, on average, only 20mm fall. During the dry spell, La Paz relies on meltwater from glaciers and snow melt from nearby high peaks in the Andes.

The central part of La Paz has been built in a valley created by the Choqueyapu River. The river is contained in a canyon through most of the city. The canyon has been covered throughout most of the city, so there are few places where the river is visible.

Water can be extracted from the Choqueyapu River in the El Centro region of the city. Pipelines carry water from El Centro to Zona Sur area. There is little access to water in the rapidly-growing El Alto area of the city.

Source: www.maclester.edu

Figure 9 Annual average temperature and rainfall for La Paz



Source: www.climatetemp.info

Figure 10 Building over the canyon in La Paz

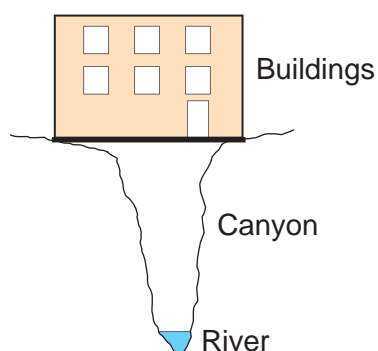


Figure 11 Main areas within La Paz

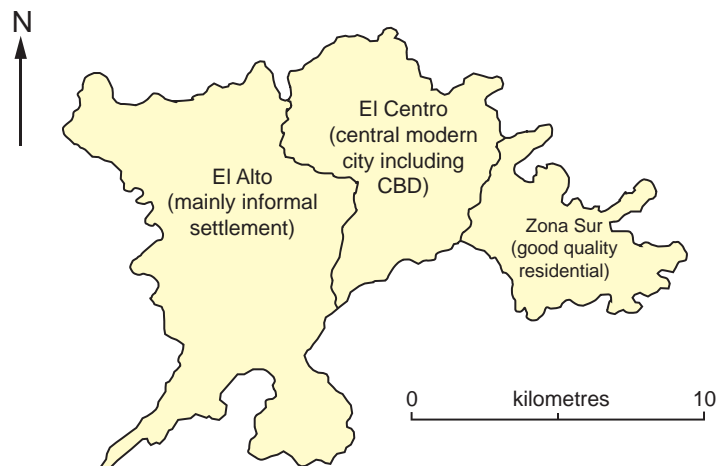
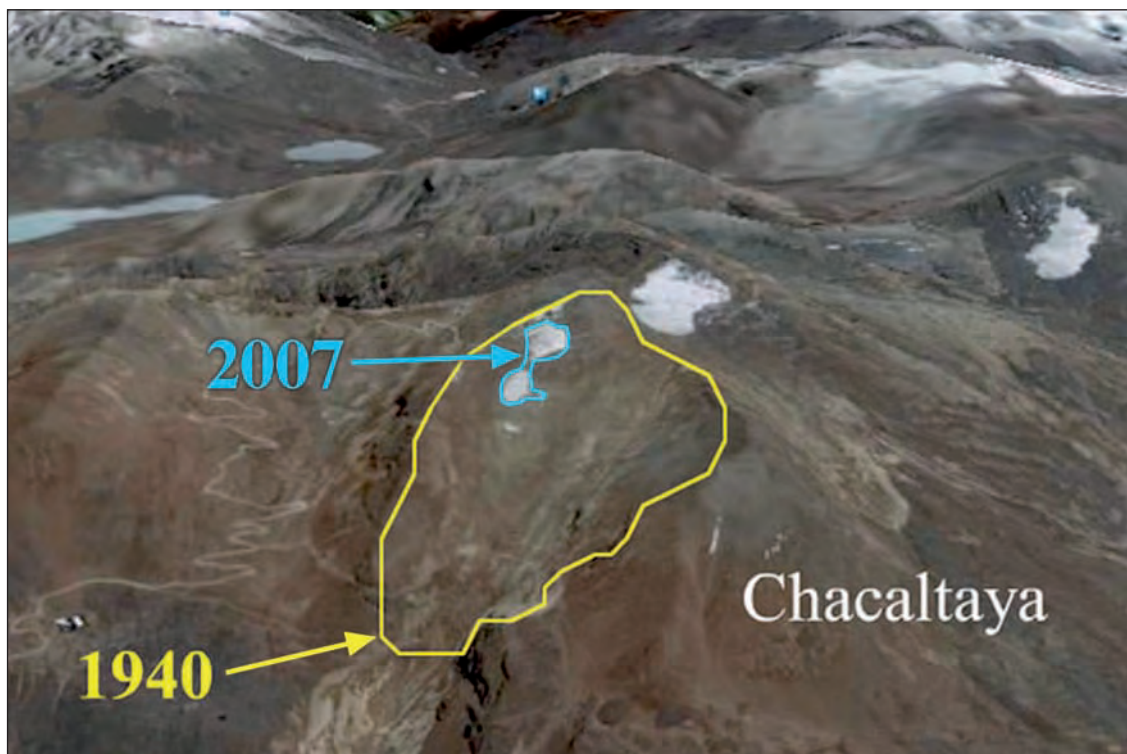


Figure 12 Threats to water supply in La Paz

Climate change is already having an impact on water supplies to La Paz. Precipitation in many parts of the Andes has declined considerably. This means that there is less run off of water from lower slopes. There is also less water from melting snow and glaciers from higher altitudes.

One glacier and snowfield which has helped provide water to La Paz is on the mountain Chacaltaya. The photograph shows the extent of the glacier in 1940 and 2007. It is at an altitude of 5 300m and once had the highest ski resort in the world. In 2005 the University of San Andres in La Paz was predicting that the Chacaltaya glacier would disappear by 2015. This actually happened in 2009. The difficulty is that this source of meltwater has now gone, and almost all the other sources that supply La Paz have also disappeared.

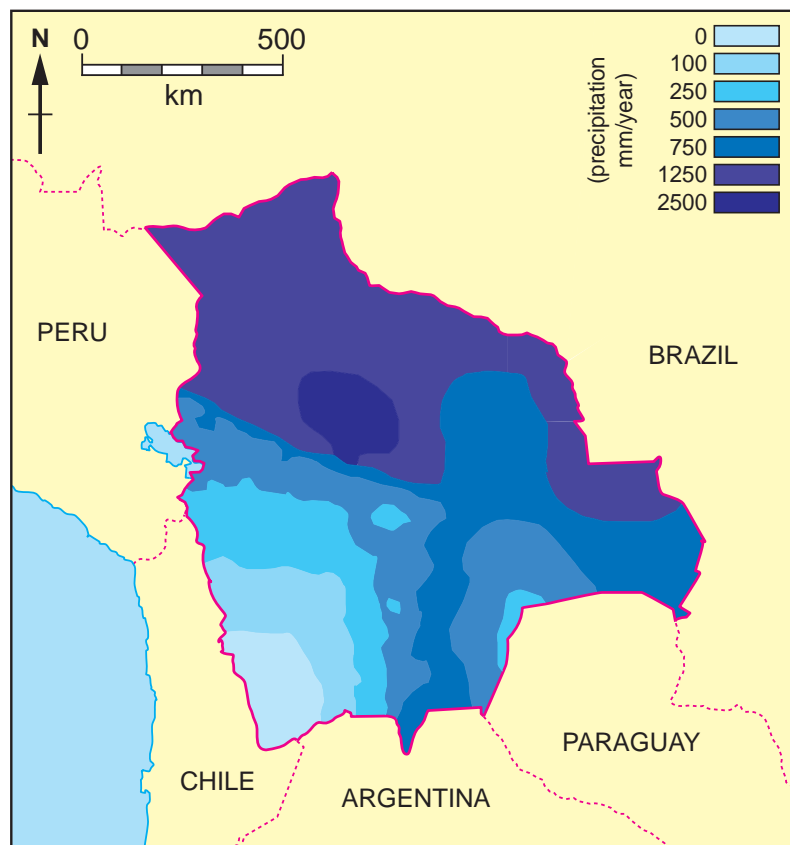


There is still meltwater coming from ice on the multiple peaks of Illimani which is also near to La Paz. Between Illimani and La Paz are many villages, such as Khapi. The villagers depend on meltwater to irrigate their crops of potatoes, maize and beans. But in recent years the flow has been reduced, and often the water that does flow is discoloured — there is just not enough water to disperse impurities.

One response to the deteriorating conditions has been for villagers to leave the village and move to La Paz. In the last 10 years 15 families have left Khapi leaving only 45 families remaining. The only area they can afford to move to in La Paz is El Alto. Ironically this part of the city has the least water available of any. The water in this district is almost always contaminated with sewage.

Water supplies are not just a problem in La Paz. To the south-east, in the city of Cochabamba, water supplies were privatised in 1999. As a result, families earning US\$80 per month were having to pay out US\$20 for water. In 2000 there were a series of so-called 'water wars' in the city. As a result, the privatisation was reversed. This initially helped to reduce the cost of water, but did nothing to increase supplies.

Source: news.bbc.co.uk

Figure 13 Precipitation distribution in Bolivia

Most of the main cities of Bolivia are located in the Altiplano and Andean Valley regions. It is only in these parts of Bolivia that precipitation is low. Located on high, flatter areas within the Andes, they are in a rain shadow. The rain-bearing winds of Bolivia blow from the north-east where the air mass picks up large amounts of moisture over the warm Atlantic Ocean. The north-easterlies first cross the Amazon Basin where much of the moisture falls. Then the air is forced up the eastern slopes of the Andes in the Yungas region. Relief rainfall results, so there is little moisture remaining by the time the north-easterly winds reach the Altiplano and Andean Valleys. Between May and August the north-easterly winds migrate northwards hardly reaching the mountains, so very little moisture is brought to the area at that time.

Few people live in the Amazon rainforest, but for the few who do there is plentiful rainfall throughout the year. Located to the north of the country, the rainforest is still in the zone reached by the north-easterly winds, even when this wind belt as a whole migrates northwards.

To the east of the country, and to the south of the rainforests, are the Eastern Lowlands. Rainfall here is generally lower than in the Amazon Basin, but is adequate for the low numbers of people who live in the area. Once again it is the north-easterly winds that carry moisture to the area bringing plentiful rain between September and April. From May to August, south-easterly winds move into this part of the country. These winds carry little moisture in them creating a dry season.

The extreme south-western parts of the Andes receive hardly any rain. They can be considered as highland areas of the Atacama Desert.

In Bolivia, the relationship between population density and precipitation is inverse.

FOOD SUPPLY

Figure 14 Farming in Bolivia

Approximately one third of the population of Bolivia is engaged in agriculture. The nature of the farming varies greatly from region to region. Most Bolivians have enough to eat most of the time, but the availability of food is not certain.

Altiplano and Andean Valleys

- 60% of Bolivian farmers
- Farmers just beyond the subsistence level
- Provide for a basic family diet and 30% sold
- Work done by hand plus limited use of animal power
- Potatoes, maize, beans and quinoa
- Sheep, llamas and alpaca provide milk, meat and fibres
- Plots between one and three hectares
- Crops are grown on terraces on steep slopes
- Soil erosion and over-grazing can be problems



Terraces in Altiplano



Coffee growing in Yungas

Yungas

- 20% of Bolivian farmers
- Mostly fertile, holdings between 5 and 10 hectares
- More commercial, but mechanisation limited
- Maize and wheat on higher ground, coffee lower down
- Coca (source of cocaine) grown, crop often destroyed by government, need to deal with violent criminals
- Sugar cane and tropical fruits on the lower slopes

Amazonian Rainforest

- 5% of Bolivian farmers
- Not as developed as in Brazil
- Logging, cattle rearing and rice growing
- Farms between 50 and 75 hectares
- Commercial enterprises for export



Logging in the Rainforest



Eastern Lowlands

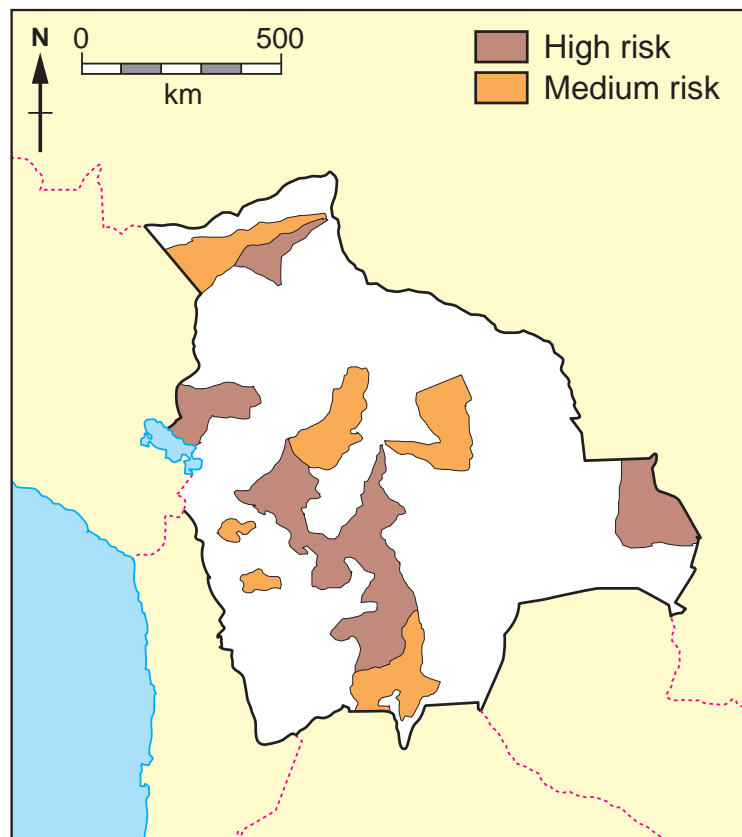
- Farms of up to 5 000 hectares exist
- Soya beans, rice, maize and coffee
- Drier areas have sheep and cattle
- All the farms commercial with some research and development
- Much specialised equipment
- Food sent to cities in Bolivia and export market

Sheep in Eastern Lowlands

Source: research.cip.cgiar.org

Turn over.

Figure 15 Food security – areas of high and medium risk of food shortage



Source: www.fhi.net

Figure 16 Food shortages in Bolivia

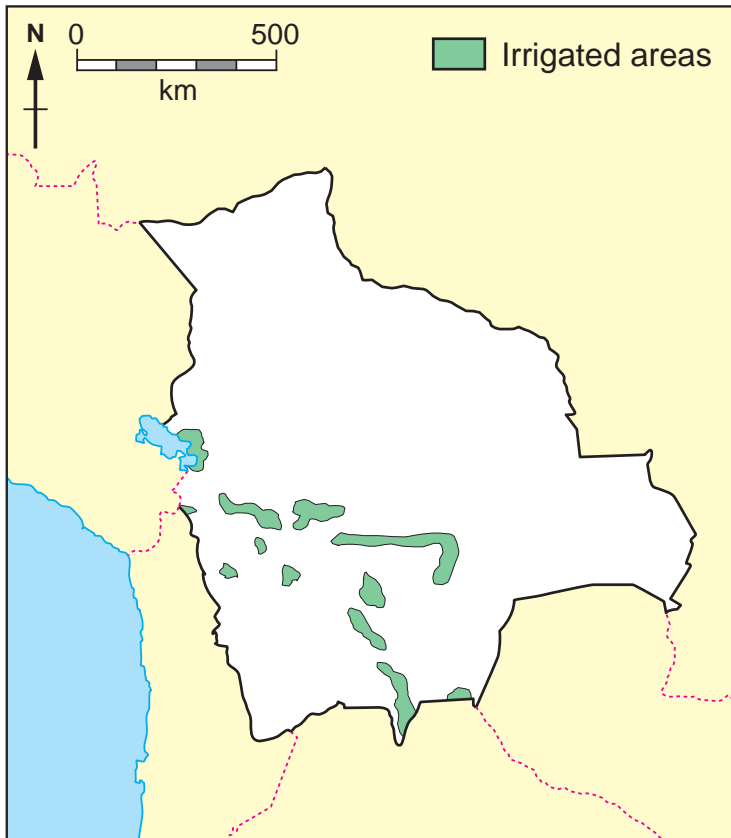
Food shortages occur in Bolivia for two main reasons. In the Altiplano there are frequent droughts, but in many of the lowland areas, flooding is a major threat.

Both the droughts and the flooding have a common cause, that is, the El Niño southern oscillation. This is a warming of the eastern Pacific Ocean off the west coast of South America that occurs every seven years or so. It has an impact on the weather throughout the world but is most pronounced in countries close to the warming.

The warming intensifies (strengthens) tropical storms so that they are more severe with heavier rainfall. The warming also alters pressure patterns so that the routes followed by some rain bearing systems are diverted. Therefore they do not reach some areas normally in their path.

Bolivia normally imports only a small amount of wheat into the country in order to ensure an adequate diet for most of the population. When droughts or floods occur, food does need to be imported to replace food that is lost. This is often shipped into the country as aid. It is difficult to respond quickly with food aid for Bolivia. Bolivia is landlocked, there is no port for shipping to use. To the whole of the west of the country, the Andes form a very high barrier with only a few, very difficult roads. To the north and north-east is the huge Amazon Basin, which also has only a few difficult route-ways. To the south and south-east, there are huge distances across Argentina or Paraguay to cross before reaching points accessible to the outside world. Transport is expensive and improving it would be a strain on the Bolivian economy.

Source: www.bolivia.usaid.gov

Figure 17 Irrigated areas of Bolivia

Source: www.geo.uni-frankfurt.de

Figure 18 Irrigation and food production in Bolivia

Most of the irrigation in Bolivia is located in the Antiplano and Andean Valleys. Around 222 000 hectares are irrigated in the country, which is only about 4% of the cultivated land. Most of these irrigated areas are around the cities of Cochabamba (82 000 hectares) and La Paz (36 000 hectares).

The majority of the irrigation systems are just sets of canals that divert rainfall into the fields where crops are growing. Only a very small number of these have dams to catch and retain rainfall. As a result, the irrigation systems dry up when they are most needed when rainfall is limited.

Because there is little control over the flow of irrigation water, when rainfall is occasionally heavy, it can lead to soil erosion in the fields that are being irrigated. Uncontrolled irrigation is the main cause of soil erosion in Bolivia.

During times when there is little rainfall, such simple irrigation systems can cause salinity levels in the soil to rise. It is estimated that about 17% of the irrigated land has become too saline to grow crops. Where they can still be grown, yields have become severely reduced.

Source: ftp.fao.org

Figure 19 An irrigation channel in Bolivia

Source: www.betterbytheyear.org

Figure 20 The potential for irrigation in Bolivia

In Bolivia, rainfall is low and droughts are common in areas where most people live. One solution is to build dams to supply urban populations with water, but more importantly, to supply water for irrigation. Many of the valleys in the Andes are steep sided and long and often fairly narrow. So, the construction of dams in these valleys could retain considerable amounts of water.

One of the main reasons that Bolivia has not undertaken building large dams in the past has been a lack of capital to invest in such construction. Towards the end of 2009 the Inter-American Development Bank (IDB) approved a loan of US\$106 million to complete the construction of a dam across the Misicuni River near to the city of Cochabamba.

This scheme will not only increase water available for irrigation but will help to increase the supply of fresh water to Cochabamba and La Paz. In addition, the scheme will generate 80 MW of electricity.

In approving the loan the president of the IDB said, "Through this project, Bolivia is showing that when water is sustainably managed, it can become a strategic resource that generates improved human health, increased food production and greater access to clean, renewable energy."

Part of the loan will be used to reduce soil erosion, enhance water management, and protect priority habitats in the areas of the watershed most exposed to such risks.

Source: www.fao.org



Construction work on the Misicuni Dam

Figure 21 The role of aid in Bolivia

Food production and farmers' incomes in Bolivia have both increased as a result of overseas aid in Bolivia. The charity USAID has helped to finance the building of micro-irrigation projects that conserve water efficiently and direct it towards where it is needed.

Donated money is used in a number of ways. Other infrastructure has been improved. For example, roads have been given proper surfacing so that transporting food to local markets is easier and faster than it has been in the past.

In addition, money has been spent on the introduction of basic IT equipment. This has helped in several ways. For example, agricultural trainers can spread correct cultivation methods, often by such simple means as putting photographs of good practice on-line. IT also allows farmers to know current prices and which local markets are in need of the produce they have available. It generally enables them to market their food more effectively and profitably.

In times of food shortages this has allowed stocks to be moved from areas where there is a surplus to regions where supplies have been running low.

Source: www.usaid.gov

Figure 22 Other potential agricultural developments in Bolivia

Any development for agriculture is not without risk.

The greatest potential for increasing food production in Bolivia is to develop the rainforest areas. To increase food supplies for the people of Bolivia would involve adopting methods at the cutting edge (forefront) of current research. The Bolivian government would struggle to fund this research. Opportunities to receive overseas funding for this are limited too.

In order to bring about economic development for the country so that all additional food needs could be imported, it would make sense to clear the native forest and plant oil palm, grow soya beans or adopt other commercial farming. This presents Bolivia with a problem. It holds a great deal of untouched rainforest. Rainforest covers 54% of the country and half of this is completely natural. This is not a result of intentional (planned) conservation. As the government is based in the Andes, the rainforest has been neglected. In addition, parts of the national debts have been written off in exchange for creating forest reserves. Maintaining rainforest is important globally, but further payments to Bolivia to keep the reserves complete are unlikely.

The greatest loss of rainforest occurred in 2005 when a small area being burnt to create a small patch of land for agriculture got out of control and half a million hectares were destroyed (1.7% of the natural forest).

Source: www.worldfoodprize.org



Rainforest burning



An oil palm plantation

Figure 23 Agricultural improvement programmes in Bolivia

Two programmes that appear promising in helping other areas of Bolivia are:

1 Strategies for International Development (SID)

One of its recent projects was helping farmers reclaim and transform parched land into productive pastures. In limited trials so far farmers have, on average, increased their income from US\$320 a year to US\$600 a year. The goal is to raise the income to US\$900 a year, but the community needs more money and training. However, it is very challenging to find additional funding.

2 Small Farmers Technical Assistance Service Project (PROSAT)

This has been paid for by the International Fund for Agricultural Development, and is a six-year World Bank pilot project to strengthen rural communities through technical assistance. The aim is to target 206 000 poor rural families, but only a fraction of this number has been helped so far. The total estimated cost will be US\$28.3 million. Being a project sponsored by the World Bank, it is likely that this funding will be provided. So far, in limited trials, potato yields have increased by 2.5 tonnes per hectare and have increased food security in the small areas where trials are under way.

Source: www.ifad.gov

Sources of information

- Figure 1 <https://www.cia.gov/library/publications/the-world-factbook/geos/bl.html> & <http://countrystudies.us/bolivia/>
- Figure 2 <http://www.worldatlas.com/webimage/countrys/samerica/lcolor/bocolor.htm>
- Figure 3 <http://www.southwindadventures.com/map-bol.htm>
- Figure 4 <http://www.cia.gov/library/publications/the-world-factbook/>
- Figure 5 <https://www.cia.gov/library/publications/the-world-factbook/> & <http://faostat.fao.org/site/368/default.asp#ancor>
- Figures 6 & 7 <ftp://faostat.fao.org/agl/aglw/aquastat/GMIAv401hires.pdf>
- Figure 8 <http://www.macalester.edu/courses/geog61/amartin/elalto.html>
- Figure 9 <http://www.climatetemp.info/bolivia/la-paz.html>
- Figure 12 <http://news.bbc.co.uk/1/hi/sci/tech/8394324.stm>
- Figure 13 http://www.bestcountryreports.com/Precipitation_Map_Bolivia.html
- Figure 14 https://research.cip.cgiar.org/confluence/download/attachments/13021/Bolivia_Feb_2006.pdf
- Figure 15 <http://www.fhi.net/fhibolivia/challenge.htm>
- Figure 16 <http://bolivia.usaid.gov/US/6Fs.htm>
- Figure 17 http://www.geo.uni-frankfurt.de/ipg/ag/dl/f_publicationen/1999/doell_siebert_kwws1.pdf
- Figure 18 <http://www.fao.org/nr/water/aquastat/countries/bolivia/indexesp.stm>
- Figure 19 <http://www.betterbytheyear.org/bolivia/gallery/image13.htm>
- Figure 20 <http://www.fao.org/countryprofiles/index.asp?lang=en&ISO3-bol&subj=4>
- Figure 21 <http://www.usaid.gov/pubs/cbj2002/lac/bo/511-002.html>
- Figure 22 <http://worldfoodprize.org/assets/YouthInstitute/06proceedings/DavenportCentralHS.pdf>
- Figure 23 http://www.ifad.org/evaluation/public_html/eksyst/doc/country/pl/bolivia/bo.htm



GCE A level

1204/01-B

**GEOGRAPHY - G4
SUSTAINABILITY**

**Pre-Release Material for examination
on 17 June 2011.**

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 Folder contains information about water supply and food production in Bolivia. It examines threats to the water supplies and difficulties encountered in the country's agriculture. Plans to boost water supplies and stimulate agricultural output are also presented.

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 at 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 rewarded in answers. 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. Many are only extracts or shortened versions of fuller documents. Some lengthy sources may have been adapted by extensive re-writing to condense them. It is well worth following these links for greater depth of reading and for more recent updates of material.

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.

Contents

	Page
BACKGROUND TO BOLIVIA	
Figure 1	Introduction to Bolivia 4
Figure 2	Relief regions of Bolivia 5
Figure 3	Regions of Bolivia 5
Figure 4	Indicators for Bolivia and selected countries 6
Figure 5	Rate of natural increase and daily calorie intake for selected countries 6
Figure 6	Water usage in selected countries 7
Figure 7	Water sources in selected countries 7
WATER SUPPLY	
Figure 8	Water supply to La Paz 8
Figure 9	Annual average temperature and rainfall for La Paz 8
Figure 10	Building over the canyon in La Paz 8
Figure 11	Main areas within La Paz 8
Figure 12	Threats to water supply in La Paz 9
Figure 13	Precipitation distribution in Bolivia 10
FOOD SUPPLY	
Figure 14	Farming in Bolivia 11
Figure 15	Food security – areas of high and medium risk of food shortage 12
Figure 16	Food shortages in Bolivia 12
Figure 17	Irrigated areas of Bolivia 13
Figure 18	Irrigation and food production in Bolivia 13
Figure 19	An irrigation channel in Bolivia 13
Figure 20	The potential for irrigation in Bolivia 14
Figure 21	The role of aid in Bolivia 14
Figure 22	Other potential agricultural developments in Bolivia 15
Figure 23	Agricultural improvement programmes in Bolivia 15
Sources of information	16

BACKGROUND TO BOLIVIA

Figure 1 Introduction to Bolivia

Bolivia is a landlocked country in South America.



(2010 estimates)	Bolivia	UK
Population	9 775 246	61 113 205
Land area (km ²)	1 098 581	241 610
Water area (km ²)	15 280	1 680

There are several quite distinct regions. The largest region is rainforest in the north of the country. This is part of the Amazon Basin. This area has been developed very little and the population of the area is very low.

Much of the west of the country is part of the Andes mountain chain. Parts are over 6 500 metres and much of this area is either too high or too steep for very much settlement.

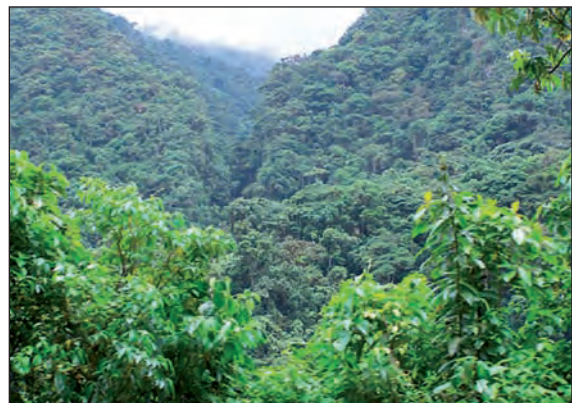
The Eastern lowlands are mainly grasslands. They are used for agriculture, but have the potential to be used much more intensively.

Most of the population live in valleys or on lower slopes to the eastern side of the Andes. These areas themselves vary in character. Between the Andes and the Amazon Basin is a transition zone, the Yungas. The Andes themselves are divided into two regions. To the west, the high peaks are in an area known as the Altiplano. In the east are many deep valleys cut into the mountains, the Andean Valleys.

The main cities are in the Altiplano, Yungas and Andean Valleys. They are La Paz (1.71 million) which is the capital, Santa Cruz (1.58 million), Cochabamba (940 000) and Sucre (270 000).



La Paz



Rainforest

Source: after www.cia.gov and countrystudies.us

Figure 2 Relief regions of Bolivia



Source: www.worldatlas.com

Figure 3 Regions of Bolivia



Source: www.southwindadventures.com

Figure 4 Indicators for Bolivia and selected countries (2010 available data)

	Argentina	Bolivia	Kenya	USA	Vietnam
Average daily calorie intake	3 004	2 175	2 039	3 825	2 650
Protein g/day	93	56	57	116	67
Food aid/capita kg	0	6.9	9.0	0	1.0
Water usage per person m ³ /day	753	157	46	1 600	847
Irrigated land km ²	15 500	1 320	1 030	223 850	30 000
Total population millions	40.9	9.78	39.0	307.2	85.9
Natural increase per thousand	10.5	18.8	26.9	5.4	10.1
Total fertility rate per woman	2.4	3.2	4.6	2.1	1.8
Life expectancy years	76.6	66.9	57.9	78.1	71.6
Literacy rate %	97.2	86.7	85.1	99.2	90.3
GDP/capita US\$	14 200	4 500	1 600	47 500	2 800
HDI (Rank)	0.87 (49th)	0.74 (113th)	0.54 (147th)	0.96 (13th)	0.73 (116th)
% in primary employment	1	40	75	<1	55

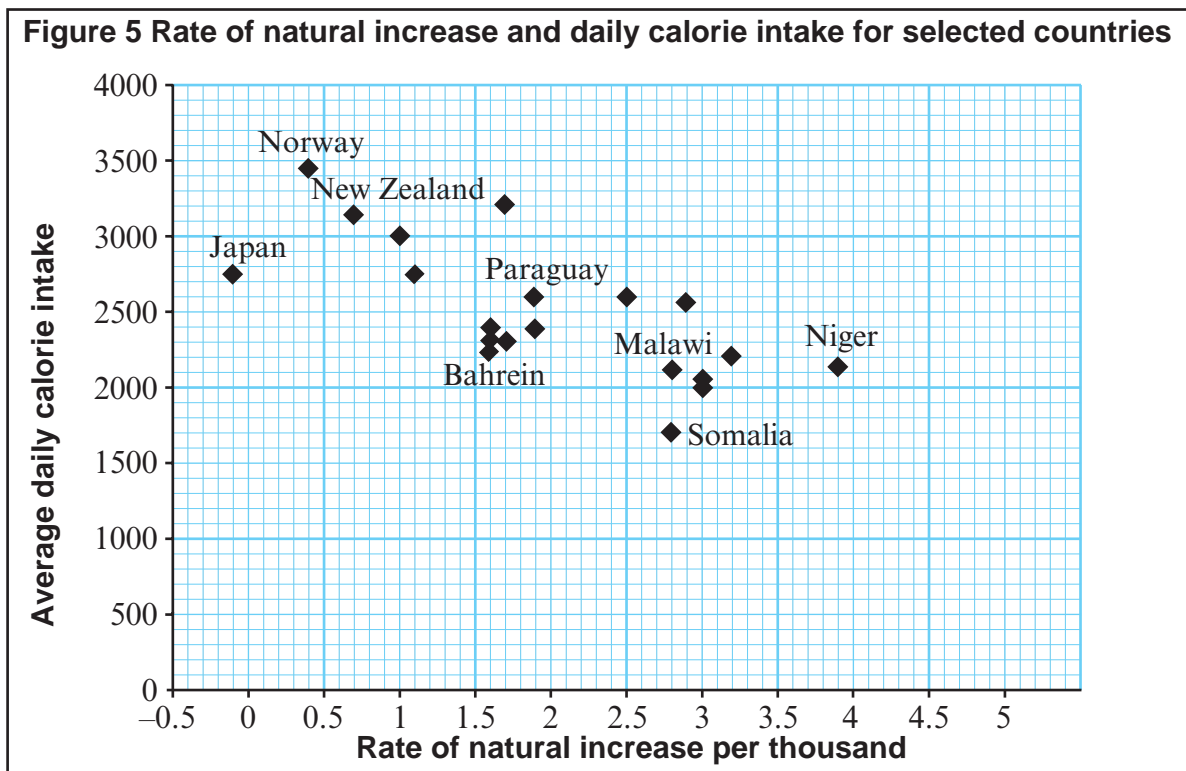
Source: www.cia.govSource: www.cia.gov&faostat.fao.org

Figure 6 Water usage (%) in selected countries

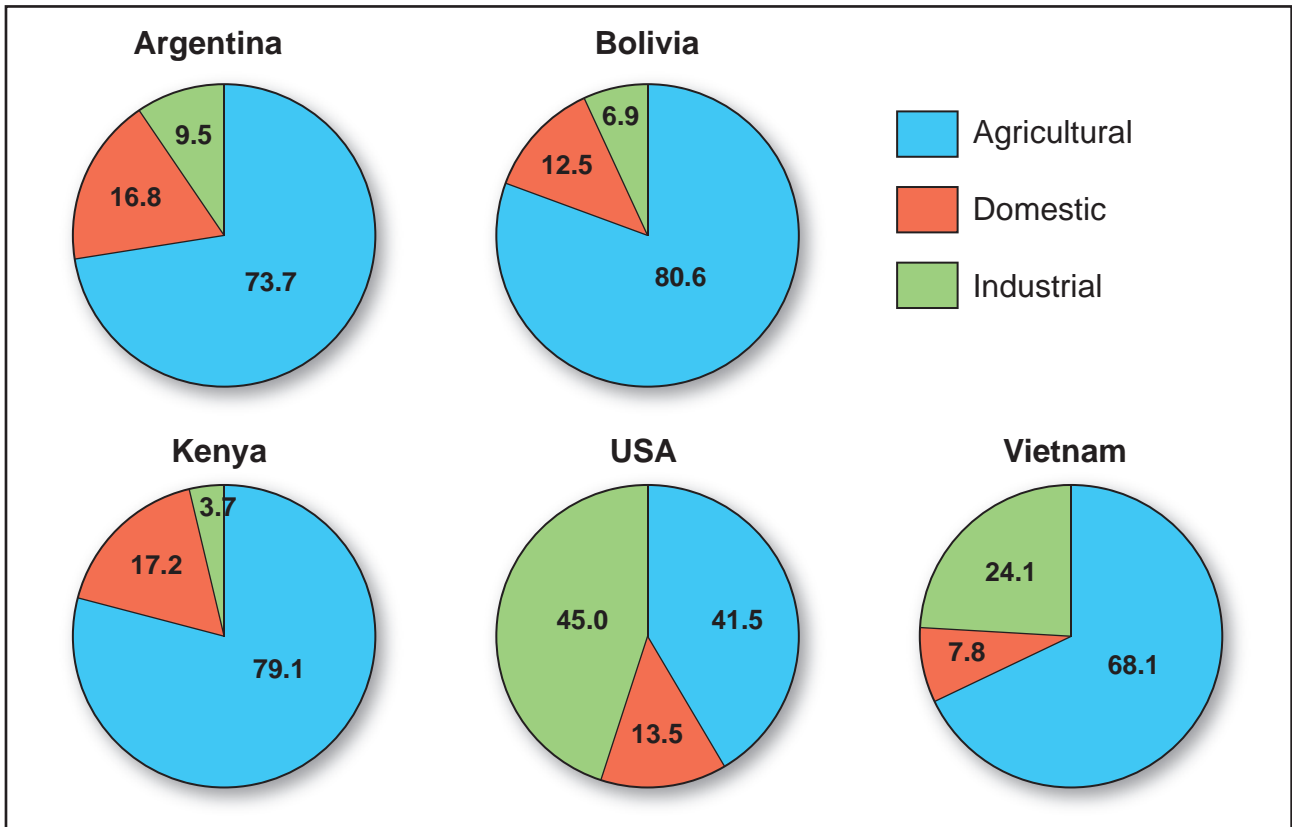
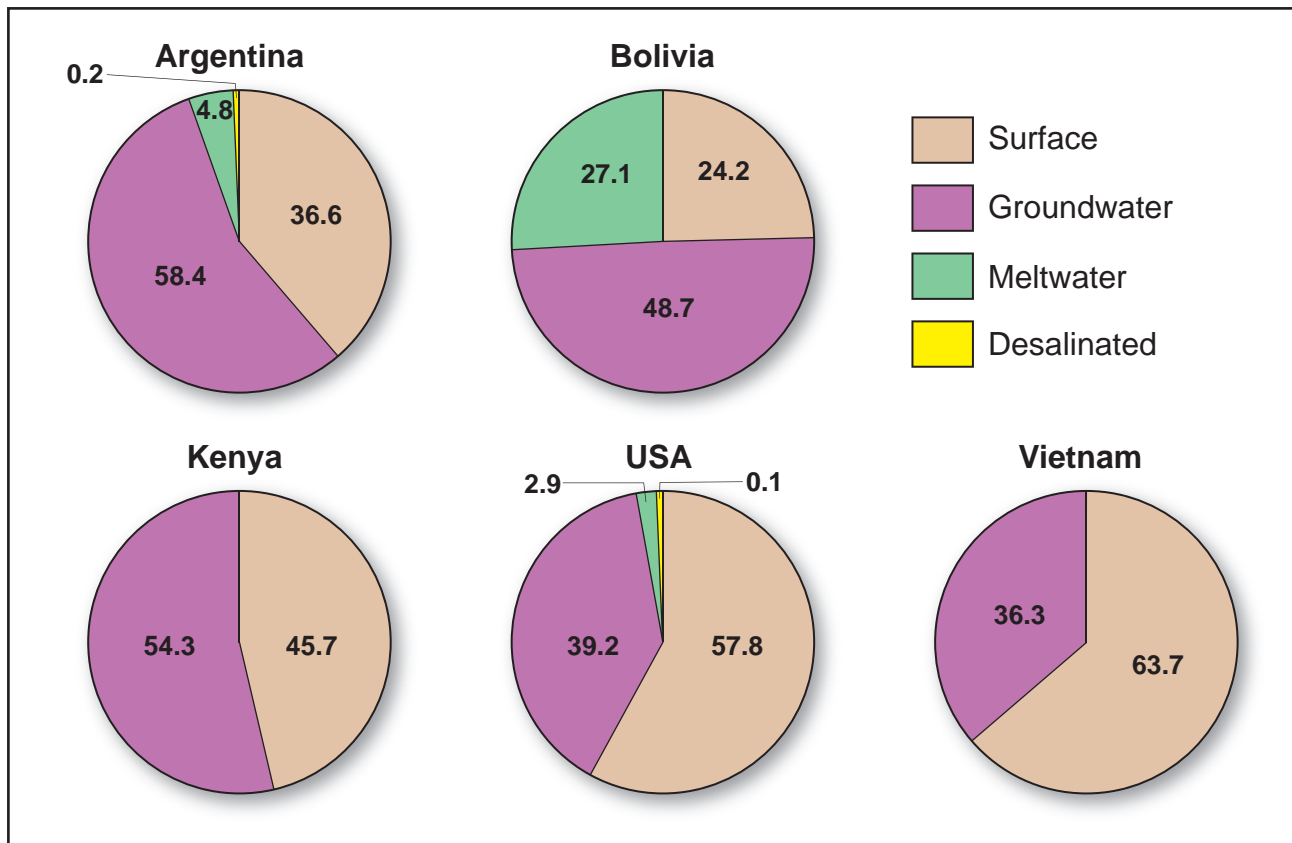


Figure 7 Water sources (%) in selected countries



Source: www.fao.org/nr/water/aquastat

WATER SUPPLY

Figure 8 Water supply to La Paz

La Paz has a relatively low rainfall of 525mm annually compared to most of the UK. For example, London receives 755mm and Cardiff 1065mm. Temperatures are similar to those within the UK, so rapid evaporation is not a great problem.

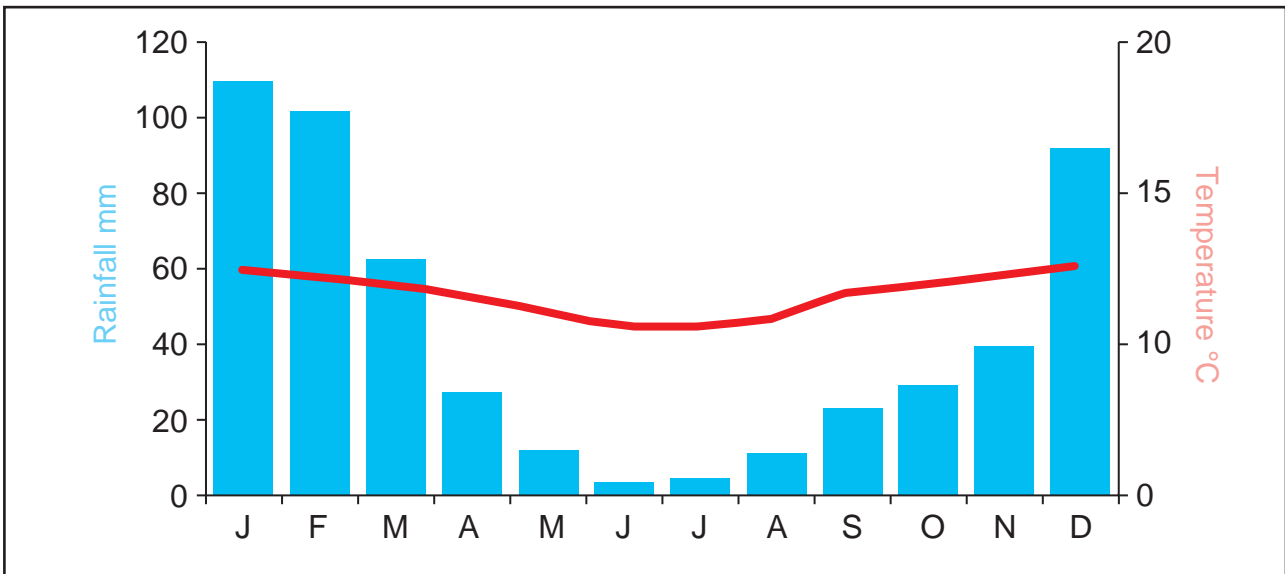
The main problem with the rainfall is that in the four months from May to August, on average, only 20mm fall. During the dry spell, La Paz relies on meltwater from glaciers and snow melt from nearby high peaks in the Andes.

The central part of La Paz has been built in a valley created by the Choqueyapu River, which is contained in a canyon through most of the city. The canyon has been covered throughout most of the city, so there are few places where the river is visible.

Water can be extracted from the Choqueyapu River in the El Centro region of the city. Pipelines carry water from El Centro to Zona Sur area, but there is little access to water in the rapidly-growing El Alto area of the city.

Source: www.maclester.edu

Figure 9 Annual average temperature and rainfall for La Paz



Source: www.climatetemp.info

Figure 10 Building over the canyon in La Paz

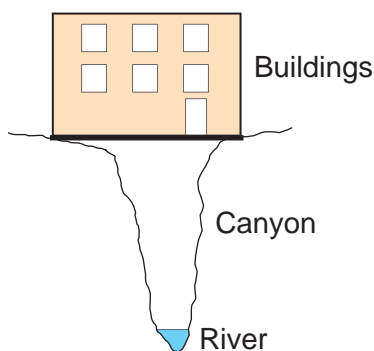


Figure 11 Main areas within La Paz

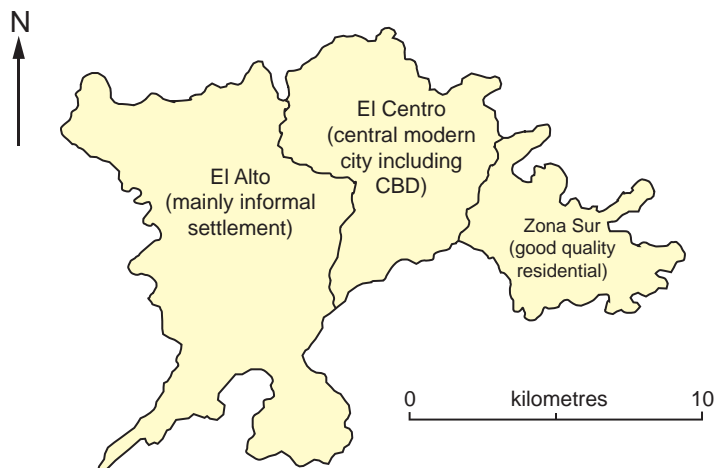
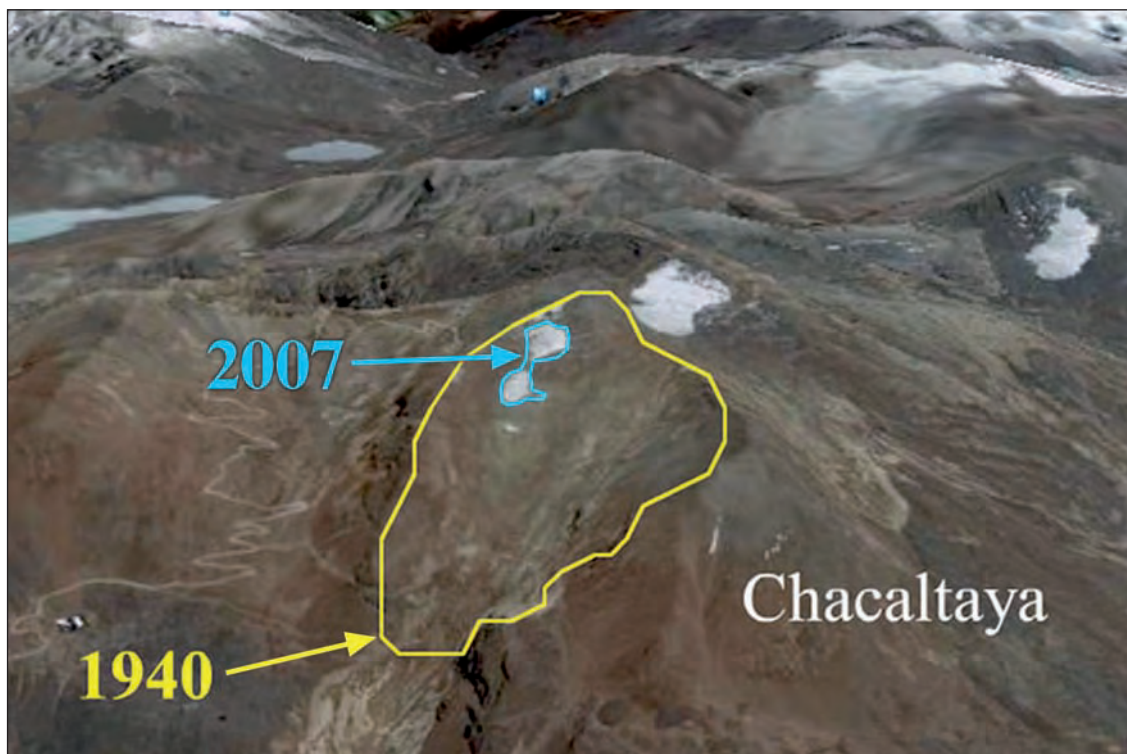


Figure 12 Threats to water supply in La Paz

Climate change is already having an impact on water supplies to La Paz. Precipitation in many parts of the Andes has declined considerably. This means that there is less run off of water from lower slopes, and less water from melting snow and glaciers from higher altitudes.

One glacier and snowfield which has helped provide water to La Paz is on the mountain Chacaltaya. The photograph shows the extent of the glacier in 1940 and 2007. It is at an altitude of 5 300m and once had the highest ski resort in the world. In 2005 the University of San Andres in La Paz was predicting that the Chacaltaya glacier would disappear by 2015. This actually happened in 2009. The difficulty is not that just one source of meltwater has gone, but that almost all sources that supply La Paz have done so.

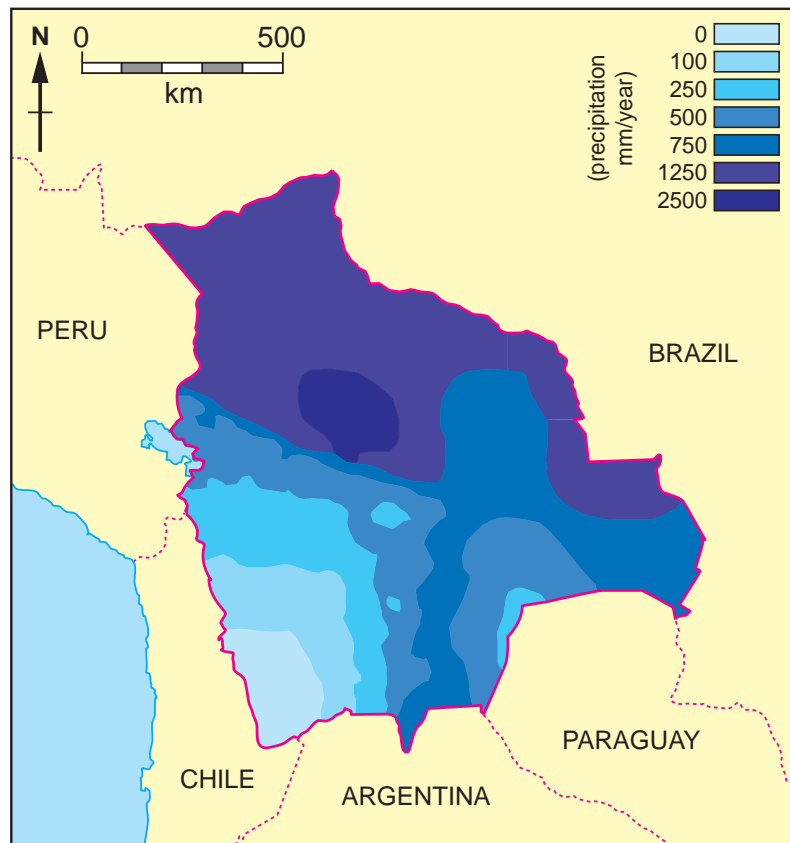


There is still meltwater coming from ice on the multiple peaks of Illimani which is also near to La Paz. Between Illimani and La Paz are many villages, such as Khapi. The villagers depend on meltwater to irrigate their crops of potatoes, maize and beans. But in recent years the flow has been reduced, and often the water that does flow is discoloured — there is just not enough water to disperse impurities.

One response to the deteriorating conditions has been for villagers to leave the village and move to La Paz. In the last 10 years 15 families have left Khapi leaving only 45 families remaining. The only area they can afford to move to in La Paz is El Alto. Ironically this part of the city has the least water available of any. What water there is in this district is almost always contaminated with sewage.

Water supplies are not just a problem in La Paz. To the south-east, in the city of Cochabamba, water supplies were privatised in 1999. As a result, families earning US\$80 per month were having to pay out US\$20 for water. In 2000 there were a series of so-called 'water wars' in the city. As a result, the privatisation was reversed. This initially helped to reduce the cost of water, but did nothing to increase supplies.

Source: news.bbc.co.uk

Figure 13 Precipitation distribution in Bolivia

Most of the main cities of Bolivia are located in the Altiplano and Andean Valley regions. It is only in these parts of Bolivia that precipitation is low. Located on high, flatter areas within the Andes, they are in a rain shadow. The rain-bearing winds of Bolivia blow from the north-east where the air mass picks up large amounts of moisture over the warm Atlantic Ocean. The north-easterlies first cross the Amazon Basin where much of the moisture falls. Then the air is forced up the eastern slopes of the Andes in the Yungas region. Relief rainfall results, so there is little moisture remaining by the time the north-easterly winds reach the Altiplano and Andean Valleys. Between May and August the north-easterly winds migrate northwards hardly reaching the mountains, so very little moisture is brought to the area at that time.

Few people live in the Amazon rainforest, but for the few who do there is plentiful rainfall throughout the year. Located to the north of the country, the rainforest is still in the zone reached by the north-easterly winds, even when this wind belt as a whole migrates northwards.

To the east of the country, and to the south of the rainforests, are the Eastern Lowlands. Rainfall here is generally lower than in the Amazon Basin, but is adequate for the low numbers of people who live in the area. Once again it is the north-easterly winds that carry moisture to the area bringing plentiful rain between September and April. From May to August, south-easterly winds move into this part of the country. These winds carry little moisture in them creating a dry season.

The extreme south-western parts of the Andes receive hardly any rain and can be considered as highland areas of the Atacama Desert.

In Bolivia, the relationship between population density and precipitation is inverse.

FOOD SUPPLY

Figure 14 Farming in Bolivia

Approximately one third of the population of Bolivia is engaged in agriculture. The nature of the farming varies greatly from region to region. Most Bolivians have enough to eat most of the time, but food security is not certain.

Altiplano and Andean Valleys

- 60% of Bolivian farmers
- Farmers just beyond the subsistence level
- Provide for a basic family diet and 30% sold
- Work done by hand plus limited use of animal power
- Potatoes, maize, beans and quinoa
- Sheep, llamas and alpaca provide milk, meat and fibres
- Plots between one and three hectares
- Crops are grown on terraces on steep slopes
- Soil erosion and over-grazing can be problems



Terraces in Altiplano



Coffee growing in Yungas

Yungas

- 20% of Bolivian farmers
- Mostly fertile, holdings between 5 and 10 hectares
- More commercial, but mechanisation limited
- Maize and wheat on higher ground, coffee lower down
- Coca (source of cocaine) grown, crop often destroyed by government, need to deal with violent criminals
- Sugar cane and tropical fruits on the lower slopes

Amazonian Rainforest

- 5% of Bolivian farmers
- Not as developed as in Brazil
- Logging, cattle rearing and rice growing
- Farms between 50 and 75 hectares
- Commercial enterprises for export



Logging in the Rainforest



Eastern Lowlands

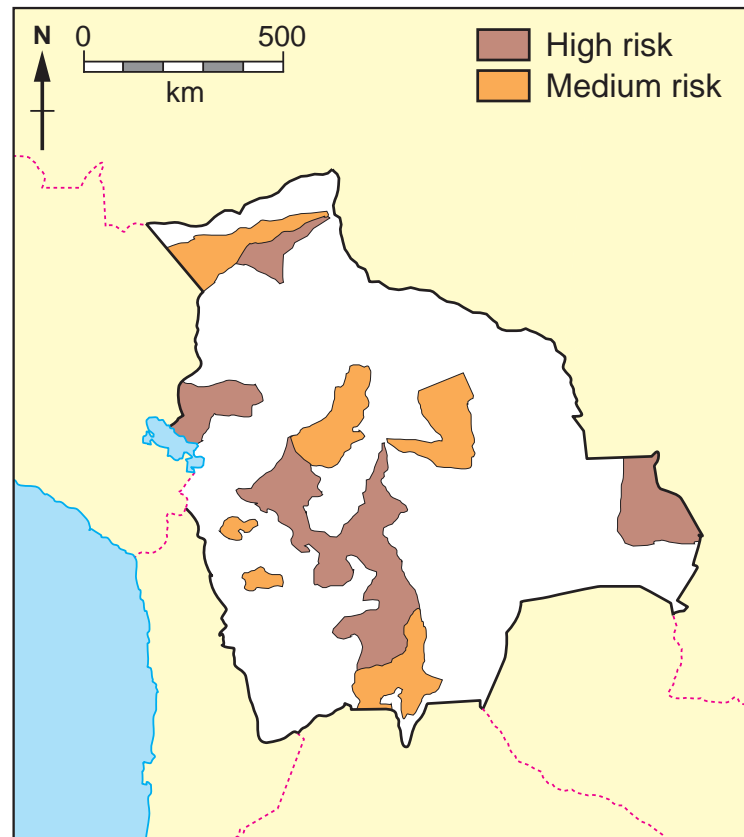
- Farms of up to 5 000 hectares exist
- Soya beans, rice, maize and coffee
- Drier areas have sheep and cattle
- All the farms commercial with some research and development
- Much specialised equipment
- Food sent to cities in Bolivia and export market

Sheep in Eastern Lowlands

Source: research.cip.cgiar.org

Turn over.

Figure 15 Food security – areas of high and medium risk of food shortage



Source: www.fhi.net

Figure 16 Food shortages in Bolivia

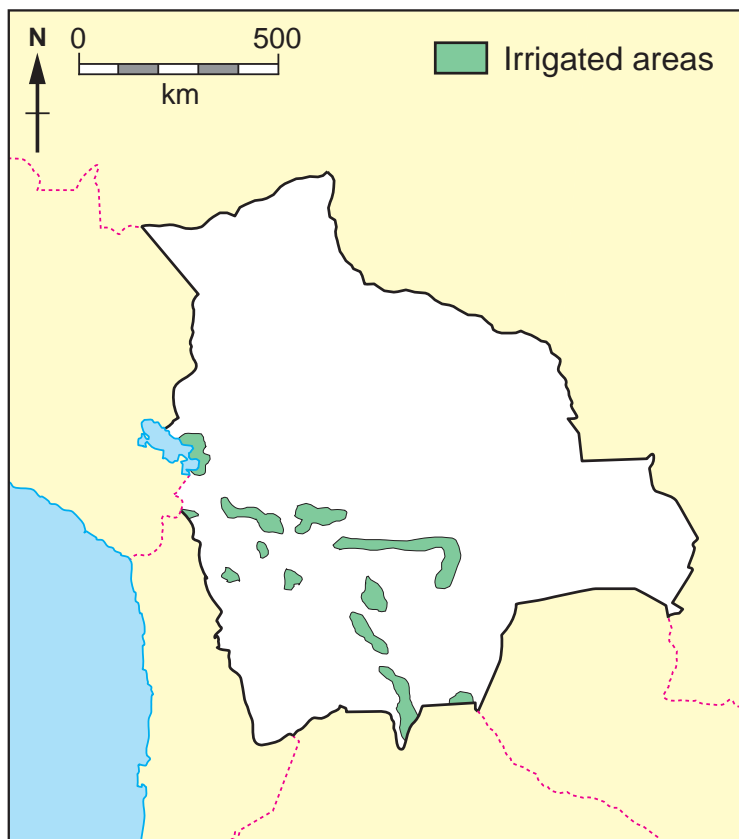
Food shortages occur in Bolivia for two main reasons. In the Altiplano there are frequent droughts, but in many of the lowland areas, flooding is a major threat.

Both the droughts and the flooding have a common cause, that is, the El Niño southern oscillation. This is a warming of the eastern Pacific Ocean off the west coast of South America that occurs every seven years or so. It has an impact on the weather throughout the world but is most pronounced in countries close to the warming.

The warming intensifies tropical storms so that they are more severe with heavier rainfall. The warming also alters pressure patterns so that the routes followed by some rain bearing systems are diverted so that they do not reach some areas normally in their path.

Bolivia normally imports only a small amount of wheat into the country in order to ensure an adequate diet for most of the population. When droughts or floods occur, food does need to be imported to replace food that is lost. This is often shipped into the country as aid. It is difficult to respond quickly with food aid for Bolivia. Being landlocked, there is no port for shipping to use. To the whole of the west of the country, the Andes form a very high barrier with only a few, very difficult roads. To the north and north-east is the huge Amazon Basin, which also has only a few difficult route-ways. To the south and south-east, there are huge distances across Argentina or Paraguay to cross before reaching points accessible to the outside world. Transport is expensive and improving it would be a strain on the Bolivian economy.

Source: www.bolivia.usaid.gov

Figure 17 Irrigated areas of Bolivia

Source: www.geo.uni-frankfurt.de

Figure 18 Irrigation and food production in Bolivia

Most of the irrigation in Bolivia is located in the Antiplano and Andean Valleys. Around 222 000 hectares are irrigated in the country, which only amounts to about 4% of the cultivated land. Most of these irrigated areas are around the cities of Cochabamba (82 000 hectares) and La Paz (36 000 hectares).

The majority of the irrigation systems are just sets of canals that divert rainfall into the fields where crops are growing. Only a very small number of these have dams to catch and retain rainfall. As a result, the irrigation systems dry up when they are most needed when rainfall is limited.

Because there is little control over the flow of irrigation water, when rainfall is occasionally heavy, it can lead to soil erosion in the fields that are being irrigated. Uncontrolled irrigation is the main cause of soil erosion in Bolivia.

During times when there is little rainfall, such simple irrigation systems can cause salinity levels in the soil to rise. It is estimated that about 17% of the irrigated land has become too saline to grow crops, and where they can still be grown, yields have become severely reduced.

Source: ftp.fao.org

Figure 19 An irrigation channel in Bolivia

Source: Saskia Fokkink/International Service

Figure 20 The potential for irrigation in Bolivia

As rainfall is low where most people live in Bolivia, and droughts are common, one solution is to build dams to supply urban populations with water, but more importantly, to supply water for irrigation. Many of the valleys in the Andes are steep sided and long, often being fairly narrow, so that the construction of dams could retain considerable amounts of water.

One of the main reasons that Bolivia has not undertaken building large dams in the past has been a lack of capital to invest in such construction. Towards the end of 2009 the Inter-American Development Bank (IDB) approved a loan of US\$106 million to complete the construction of a dam across the Misicuni River near to the city of Cochabamba.

This scheme will not only increase water available for irrigation but will help to increase the supply of fresh water to Cochabamba and La Paz. In addition, the scheme will generate 80 MW of electricity.

In approving the loan the president of the IDB said, "Through this project, Bolivia is showing that when water is sustainably managed, it can become a strategic resource that generates improved human health, increased food production and greater access to clean, renewable energy."

Part of the loan will be used to reduce soil erosion, enhance water management, and protect priority habitats in the areas of the watershed most exposed to such risks.

Source: www.fao.org



Construction work on the Misicuni Dam

Figure 21 The role of aid in Bolivia

Food production and farmers' incomes in Bolivia have both increased as a result of overseas aid in Bolivia. The charity USAID has helped to finance the building of micro-irrigation projects that conserve water efficiently and direct it towards where it is needed.

Donated money is used in a number of ways. Other infrastructure has been improved. For example, roads have been given proper surfacing so that transporting food to local markets is easier and faster than it has been in the past.

In addition, money has been spent on the introduction of basic IT equipment. This has helped in several ways. For example, agricultural trainers can spread correct cultivation methods, often by such simple means as putting photographs of good practice on-line. IT also allows farmers to know current prices and which local markets are in need of the produce they have available. It generally enables them to market their food more effectively and profitably.

In times of food shortages this has allowed stocks to be moved from areas where there is a surplus to regions where supplies have been running low.

Source: www.usaid.gov

Figure 22 Other potential agricultural developments in Bolivia

Any development for agriculture is not without risk.

The greatest potential for increasing food production in Bolivia is to develop the rainforest areas. To increase food supplies for the people of Bolivia would involve adopting methods at the cutting edge of current research. The Bolivian government would struggle to fund this research. Opportunities to receive overseas funding for this are limited too.

In order to bring about economic development for the country so that all additional food needs could be imported, it would make sense to clear the native forest and plant oil palm, grow soya beans or adopt other commercial farming. This presents Bolivia with a dilemma. It holds a great deal of untouched rainforest. Rainforest covers 54% of the country and half of this is completely natural. This is not a result of intentional conservation. As the government is based in the Andes, the rainforest has been neglected. In addition, parts of the national debts have been written off in exchange for creating forest reserves. Maintaining rainforest is important globally, but further payments to Bolivia to keep the reserves intact are unlikely.

The greatest loss of rainforest occurred in 2005 when a small area being burnt to create a small patch of land for agriculture got out of control and half a million hectares were destroyed (1.7% of the natural forest).

Source: www.worldfoodprize.org



Rainforest burning



An oil palm plantation

Figure 23 Agricultural improvement programmes in Bolivia

Two programmes that appear promising in helping other areas of Bolivia are:

1 Strategies for International Development (SID)

One of its recent projects was helping farmers reclaim and transform parched land into productive pastures. In limited trials so far farmers have, on average, increased their income from US\$320 a year to US\$600 a year. The goal is to raise the income to US\$900 a year, but the community needs more money and training. However, it is very challenging to find additional funding.

2 Small Farmers Technical Assistance Service Project (PROSAT)

This has been paid for by the International Fund for Agricultural Development, and is a six-year World Bank pilot project to strengthen rural communities through technical assistance. The aim is to target 206 000 poor rural families, but only a fraction of this number has been helped so far. The total estimated cost will be US\$28.3 million. Being a project sponsored by the World Bank, it is likely that this funding will be provided. So far, in limited trials, potato yields have increased by 2.5 tonnes per hectare and have increased food security in the small areas where trials are under way.

Source: www.ifad.gov

Sources of information

- Figure 1 <https://www.cia.gov/library/publications/the-world-factbook/geos/bl.html> & <http://countrystudies.us/bolivia/>
- Figure 2 <http://www.worldatlas.com/webimage/countrys/samerica/lgcolor/bocolor.htm>
- Figure 3 <http://www.southwindadventures.com/map-bol.htm>
- Figure 4 <http://www.cia.gov/library/publications/the-world-factbook/>
- Figure 5 <https://www.cia.gov/library/publications/the-world-factbook/> & <http://faostat.fao.org/site/368/default.asp#ancor>
- Figures 6 & 7 <ftp.fao.org/agl/aglw/aquastat/GMIAv401hires.pdf>
- Figure 8 <http://www.macalester.edu/courses/geog61/amartin/elalto.html>
- Figure 9 <http://www.climatetemp.info/bolivia/la-paz.html>
- Figure 12 <http://news.bbc.co.uk/1/hi/sci/tech/8394324.stm>
- Figure 13 http://www.bestcountryreports.com/Precipitation_Map_Bolivia.html
- Figure 14 https://research.cip.cgiar.org/confluence/download/attachments/13021/Bolivia_Feb_2006.pdf
- Figure 15 <http://www.fhi.net/fhibolivia/challenge.htm>
- Figure 16 <http://bolivia.usaid.gov/US/6Fs.htm>
- Figure 17 http://www.geo.uni-frankfurt.de/ipg/ag/dl/f_publicationen/1999/doell_siebert_kwws1.pdf
- Figure 18 <http://www.fao.org/nr/water/aquastat/countries/bolivia/indexesp.stm>
- Figure 19 Saskia Fokkink/International Service
- Figure 20 <http://www.fao.org/countryprofiles/index.asp?lang=en&ISO3-bol&subj=4>
- Figure 21 <http://www.usaid.gov/pubs/cbj2002/lac/bo/511-002.html>
- Figure 22 <http://worldfoodprize.org/assets/YouthInstitute/06proceedings/DavenportCentralHS.pdf>
- Figure 23 http://www.ifad.org/evaluation/public_html/eksyst/doc/country/pl/bolivia/bo.htm