IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M07/4/ECOSO/SP2/ENG/TZ0/XX/T

22076303

ECOSYSTEMS AND SOCIETIES
STANDARD LEVEL
PAPER 2

Tuesday 15 May 2007 (morning)

2 hours

RESOURCE BOOKLET

INSTRUCTIONS TO CANDIDATES

- Do not open this booklet until instructed to do so.
- This booklet contains **all** of the resources required to answer question 1.

2207-6303

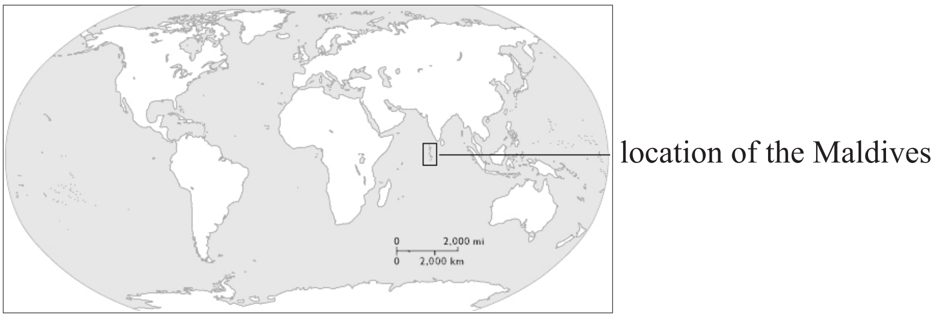
Introduction

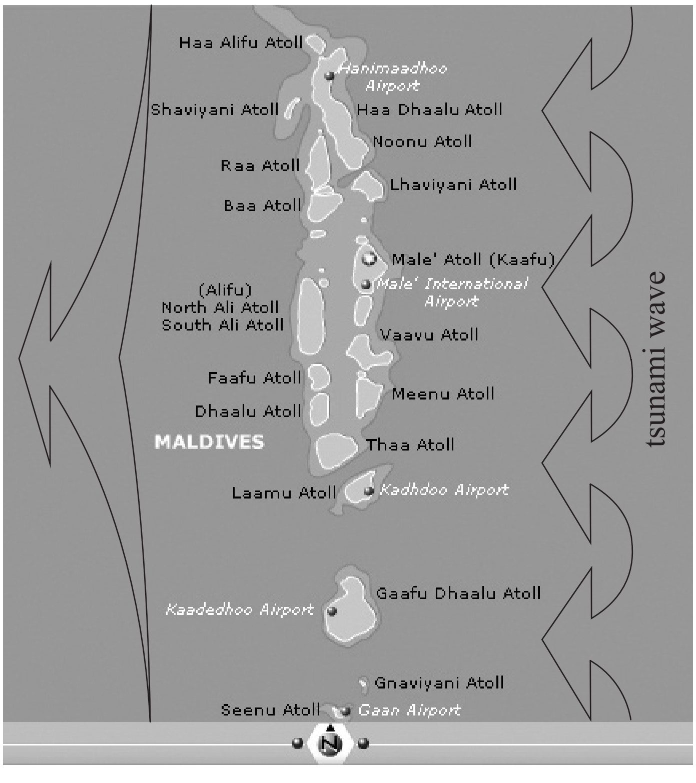
The Asian tsunami* on 26 December 2004 was caused by an undersea earthquake and had a devastating impact across the Indian Ocean, causing unprecedented human, economic and environmental damage to those countries in its path.

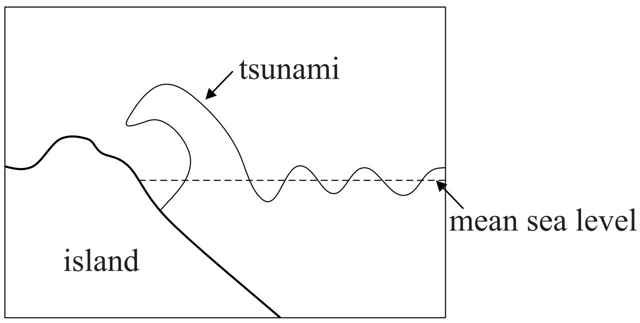
The Maldives are a chain of 200 inhabited islands, with a maximum land height above sea level of just 4 metres. The country suffered relatively small human losses, but *per capita* has sustained the largest economic damage of any country. More than 70 islands were directly affected.

* tsunami: a giant wave caused by earthquakes, volcanic eruptions or undersea landslides associated with active plate margins

Figure 1 — The Maldives and the 2004 tsunami







[Source adapted from: www.nationalgeographic.com and http://www.hoteltravel.com/maldives/maps.htm]

Figure 2 — Freshwater supply in the Maldives

Freshwater Lens formation on islands

A proportion of the freshwater falling as rain on an island infiltrates into the sandy soils and accumulates as fresh groundwater. The freshwater, being less dense than saline seawater, floats on the saline groundwater that infiltrates the island laterally at depth from the sea. Because of density differences, a freshwater lens develops, which in general is thickest at the centre of the island, where groundwater levels are highest (compared to mean sea level). The typical ratio between the height of freshwater above mean sea level compared to the depth of freshwater below mean sea level is of the order of 1:20. Groundwater levels above mean sea level on small islands may be 0.10 metres to 0.50 metres above sea level, resulting in a freshwater lens depth of 2 metres to 10 metres thick.

In the Maldives 99 % of local households use rainwater as their drinking supply and groundwater for other uses. When rainwater dries up, they use groundwater for everything. The tsunami flooded many islands with seawater which contaminated groundwater supplies. Sewage also leaks into groundwater supplies.

Figure 3 — Hydrological model of coral islands

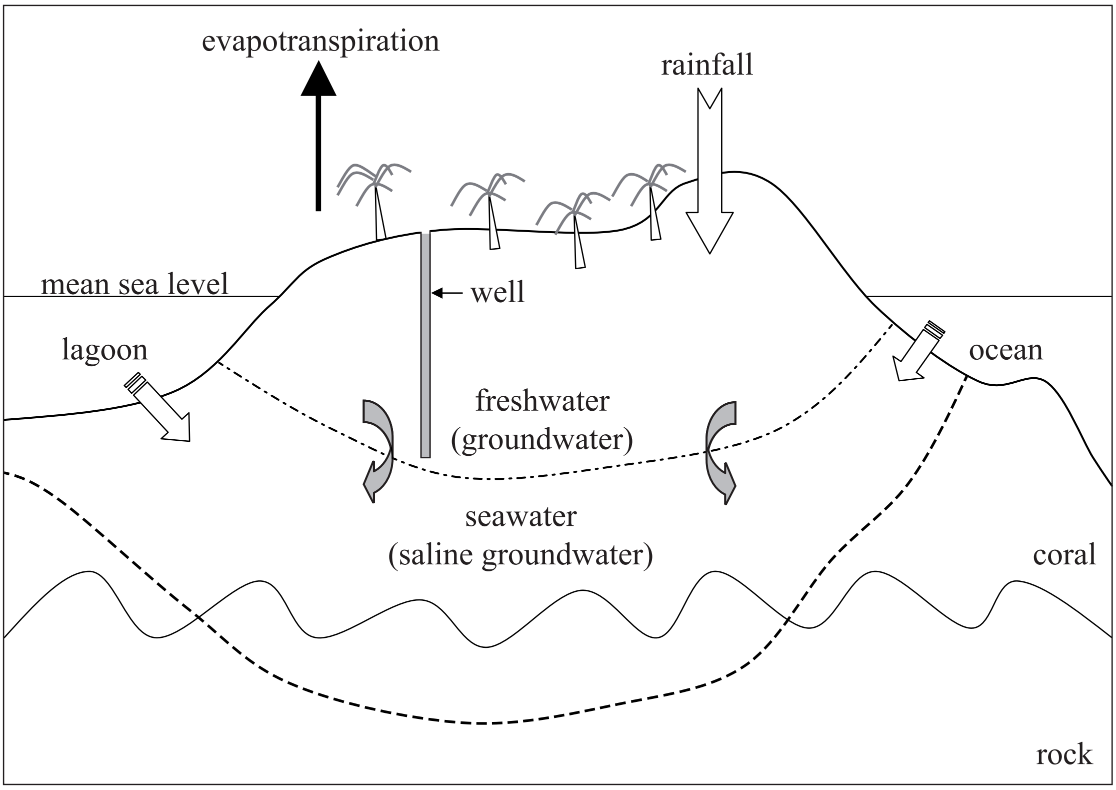


Figure 4 — Desalination prospects for the Maldives

There is a common misconception that, for small marine islands, desalination (the removal of salt from seawater) is an ideal source of freshwater. The experience throughout the small island regions of the world is that with a few exceptions, Male (the capital island) being one of them, the operation of desalination plants is in fact unsustainable.

Desalination is expensive (up to US $8/m^3 in Male) and likely to be higher on the outer islands; it requires advanced technical training not commonly available in the outer islands, it needs good cost-recovery to support complex spare part maintenance and it requires the import and storage of diesel fuels. Some or all of these factors that are required to sustain desalination are absent in small islands.

Outside of Male, resorts routinely use desalination plants. This is because tourists use large volumes of water and rainwater cannot meet demand. The small size of the islands means there is no groundwater available. The money generated by the resorts ensures engineers can adequately service the desalination plant, without which the resorts would close.

Figure 5 — Well water quality in three Maldivian islands after 2004 tsunami and the WHO (World Health Organisation) recommended maximum background levels

Island	**Nitrate / mg l^{-1}**	**Ammonia / mg l^{-1}**	**Phosphate / mg l^{-1}**	**Chloride / mg l^{-1}**
Kulhuduffushi	29.2	2.4	0.5	529
Filladhoo	32.9	6.8	0.9	1200
Dhidhdhoo	43.8	0.7	0.3	402
WHO guidelines	***50.0***	***1.50***	***Background<0.1***	***250***

Figure 6 — Climate of the Maldives

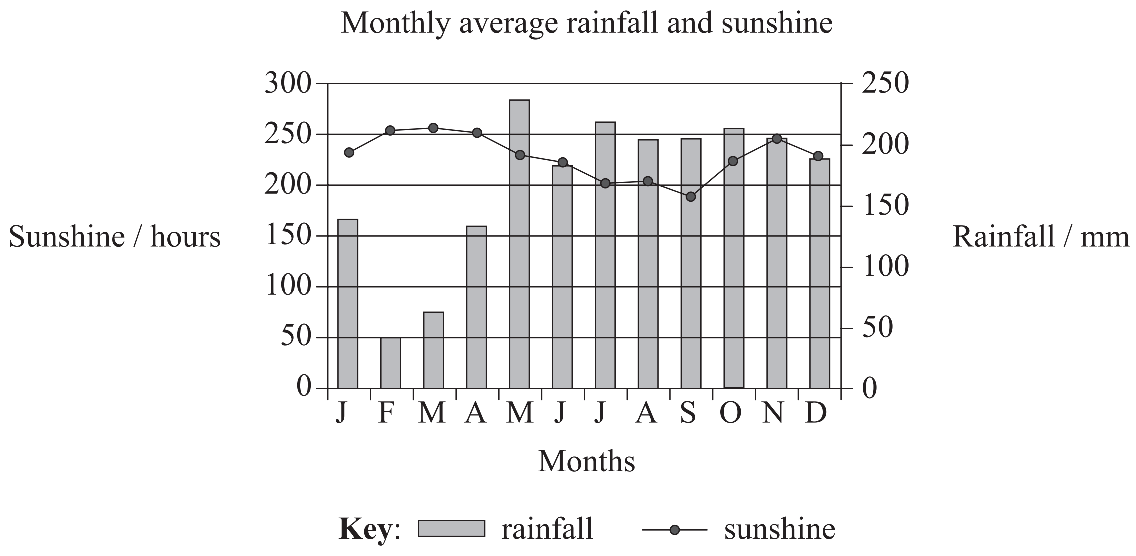


Figure 7 — Climate change and sea level rise in the Maldives

The islands of the Maldives rise, on average, up to 4 metres above sea level. In 1987 and 1991, storm surges flooded a large number of islands, including one-third of the capital where one-quarter of the country's population lives. Unusually high waves forced the international airport to close, causing great damage to tourism and constraining emergency relief operations. Recent surveys have shown that almost one-third of the 200 inhabited islands were faced with serious beach erosion problems.

Sea level rise is not a fashionable scientific hypothesis but a fact. Already in this century, the seas have risen between 10 cm and 25 cm. The prevailing scientific consensus holds that human action, affecting the world climate, will cause the seas to rise more rapidly in the future.

Countries need to pursue immediate measures by relocating their populations away from areas of risk and taking protective measures to prevent flooding. For small island countries relocation is not possible and because defences against flooding are prohibitively expensive to construct, considerable external assistance would be needed.

Figure 8 — Trends in island tourism, adapted from *www.ourplanet.com*

Tourism is expected to go on growing by approximately 5 % per year. World Tourism Organization (WTO) projections suggest that international arrivals will rise to 800 million in 2007 and one billion in 2010. The vast majority of tourists will continue to come from the developed world, but economic expansion and *per capita* income growth in developing countries – such as Brazil, China and India – will, over the long-term, add to the upward trend. This outlook makes tourism one of the most economically strong sectors of the global economy.

In order to enhance the long-term viability of the tourist sector, many small island developing countries have embarked on forward-looking strategies to improve efficiency.

Figure 9(a) — Outline map of an atoll island, indicating land above sea level

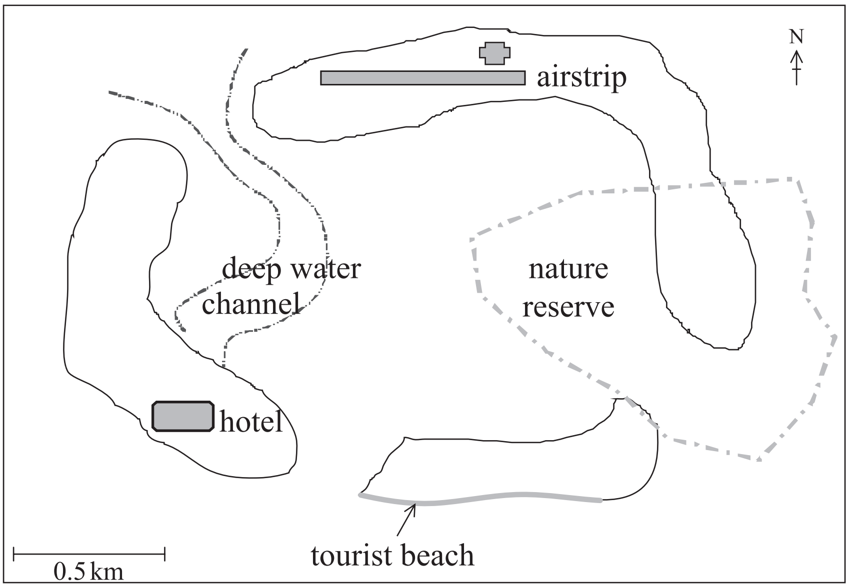


Figure 9(b) — Cross-section of an atoll island

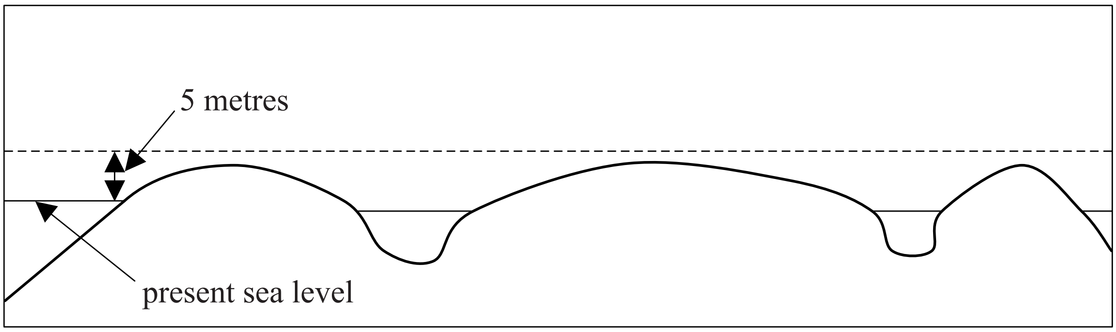


Figure 10 — Countries with chronic water scarcity (below 2740 litre capita^{-1} day^{-1}) in 2000, 2025 and 2050 compared to a number of other countries

Country	**Available water / litre capita^{-1} day^{-1} in 2000**	**Available water / litre capita^{-1} day^{-1} in 2025**	**Available water / litre capita^{-1} day^{-1} in 2050**
Saudi Arabia	325	166	118
Israel	969	738	644
Somalia	3206	1562	1015
Malawi	4656	2508	1715
UK	3337	3270	3315
India	5670	4291	3724
China	6108	5266	5140
USA	24 420	20 405	19 521

[Source adapted from: WRI 1998 in B Lomborg, 2001, *The Skeptical Environmentalist*, CUP]

Figure 11 — Percentage of people living with chronic water scarcity

2000	**2025**	**2050**
3.7 %	8.6 %	17.8 %

[Source adapted from: WRI 1998 in B Lomborg, 2001, *The Skeptical Environmentalist*, CUP]