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GROUNDWATER – UNDERSTANDING AQUIFERS

By Dr Johann van Wyk & Willem Botes (Pr. Tech Eng.)

Current Options Being Considered

(derived from various media reports)

- **Groundwater abstraction**
  Cape Flats and Table Mountain Aquifers
- **Desalination plant (400 000 m^3/day)**
  West Coast
- **Augmentation of Voëlvlei Dam**
  From Berg River
- **Re-use of Waste Water**
  Zandvliet WWTW

Considering the information supplied by City of Cape Town to the public re the alternatives to augment the water supply to Cape Town with specific reference to groundwater abstraction:

there are some doubts around the City's apparent understanding of the basic concept of groundwater abstraction and the functioning of aquifers.

Aquifers

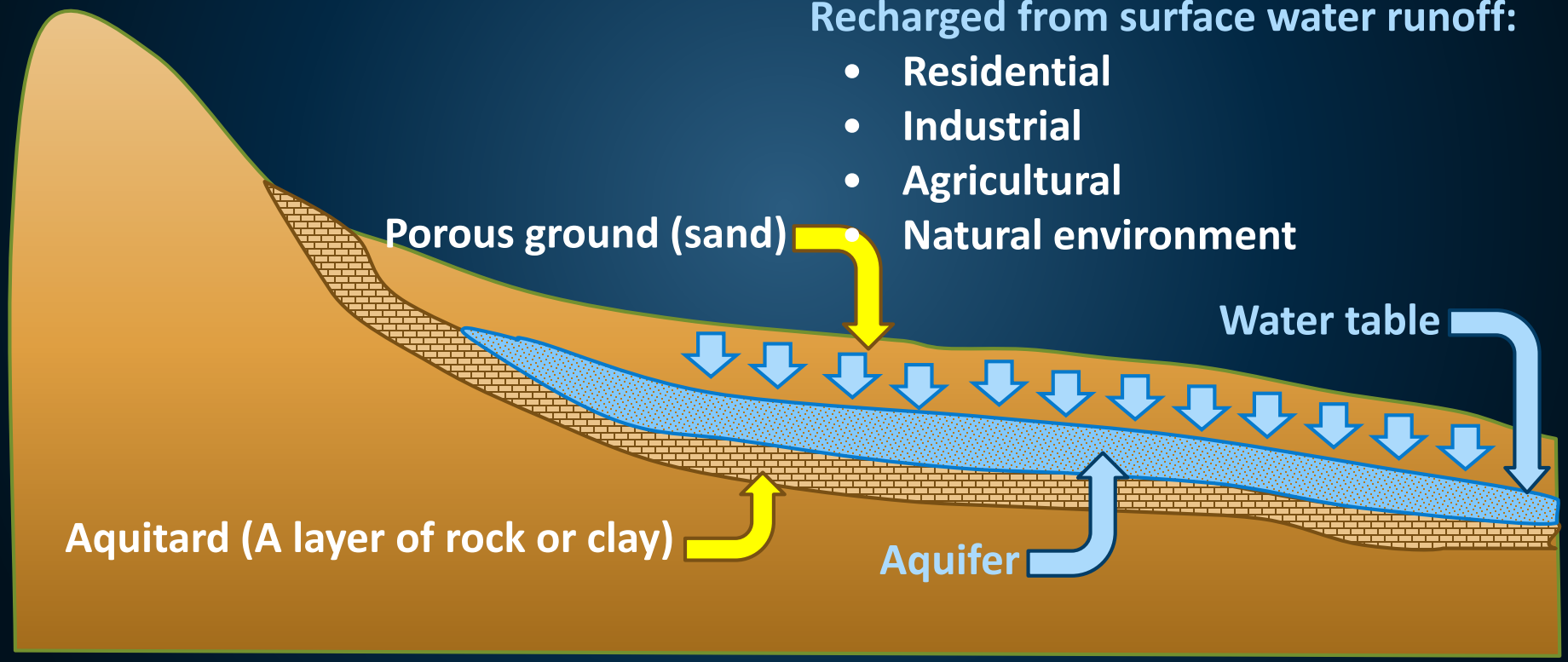
An **aquifer** is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be abstracted using a borehole or well.

There are three type of aquifers:

- **Unconfined aquifers**
- **Confined aquifers**
- **Semi-confined aquifers**

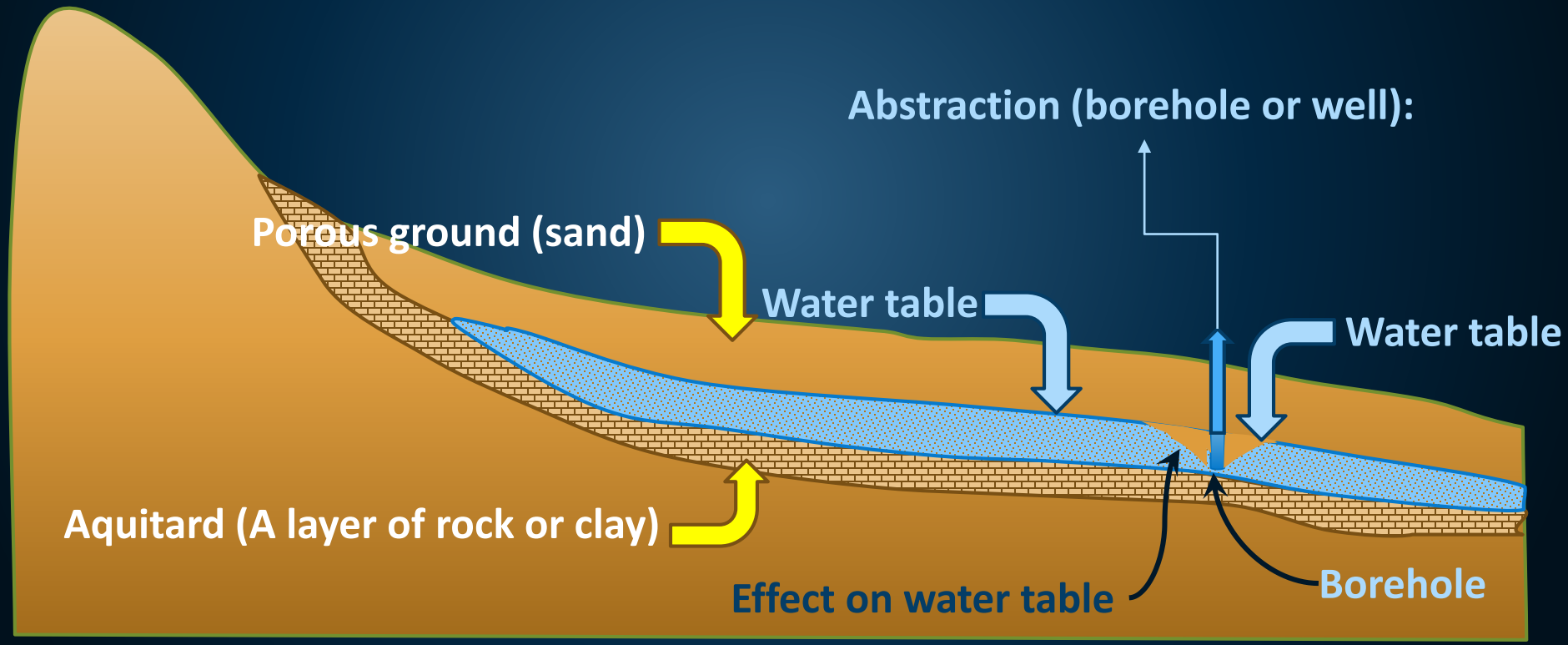
Unconfined (open) Aquifers

Where the aquifer material between the ground surface and the water table is porous it is known as an unconfined aquifer.



Unconfined Aquifers

Abstraction from an unconfined aquifer (borehole or well)



Unconfined Aquifers

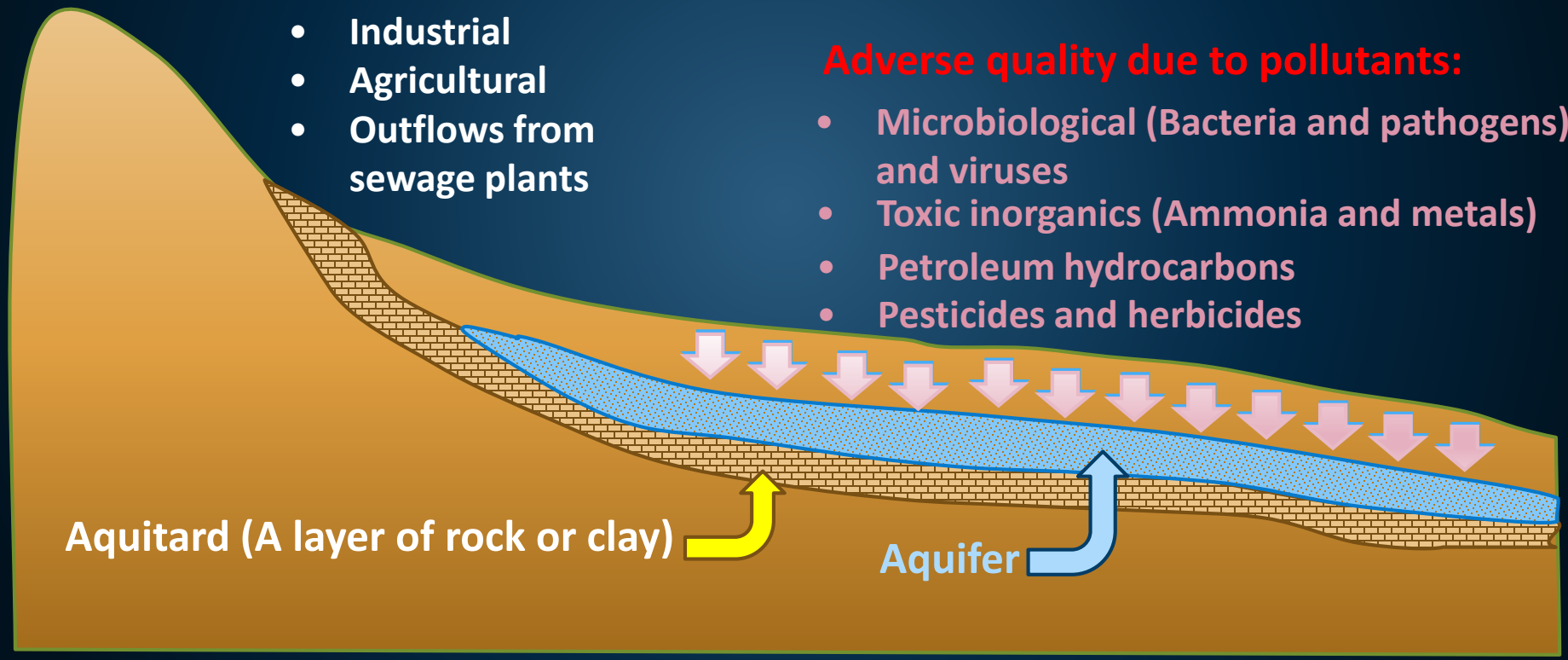
Water Quality

Recharged from surface water runoff:

- Residential
- Industrial
- Agricultural
- Outflows from sewage plants

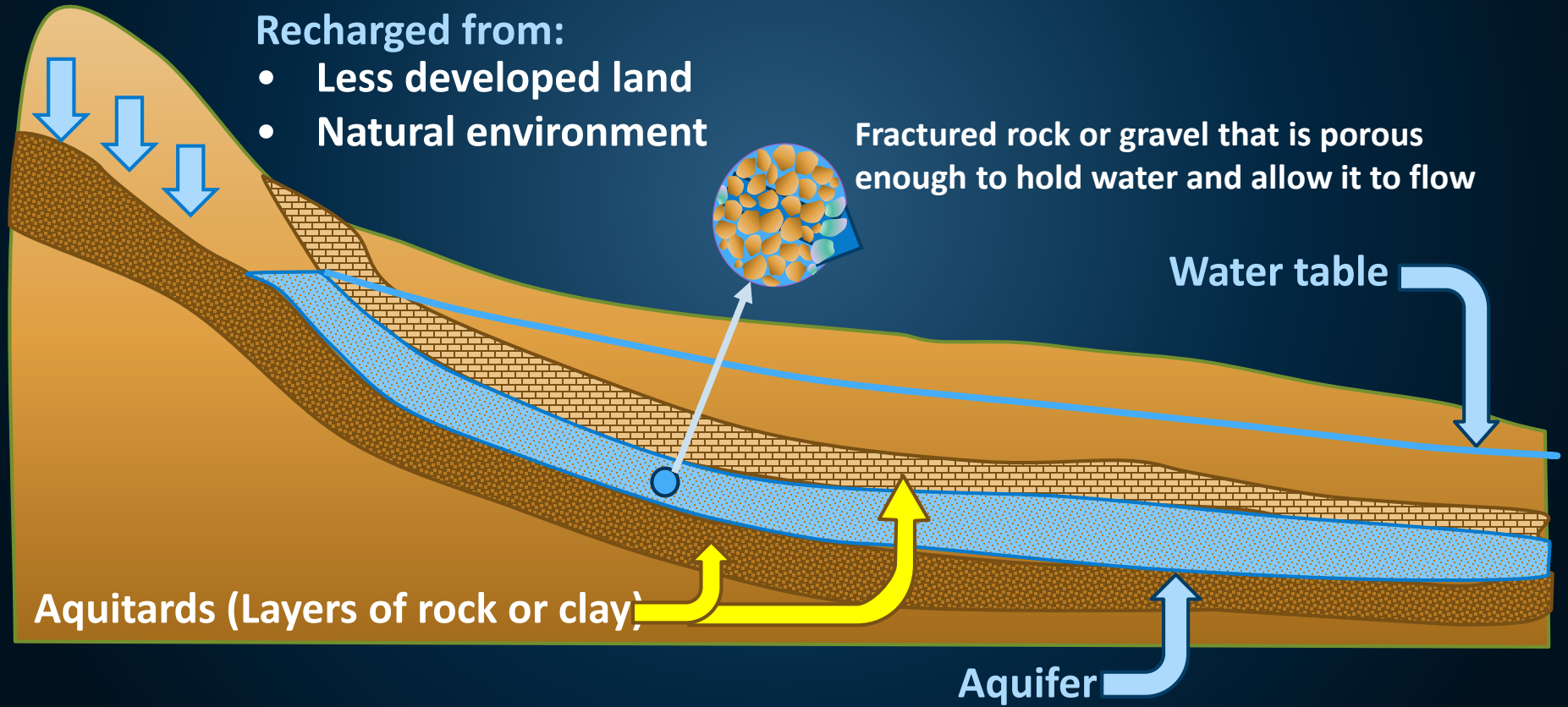
Adverse quality due to pollutants:

- Microbiological (Bacteria and pathogens) and viruses
- Toxic inorganics (Ammonia and metals)
- Petroleum hydrocarbons
- Pesticides and herbicides



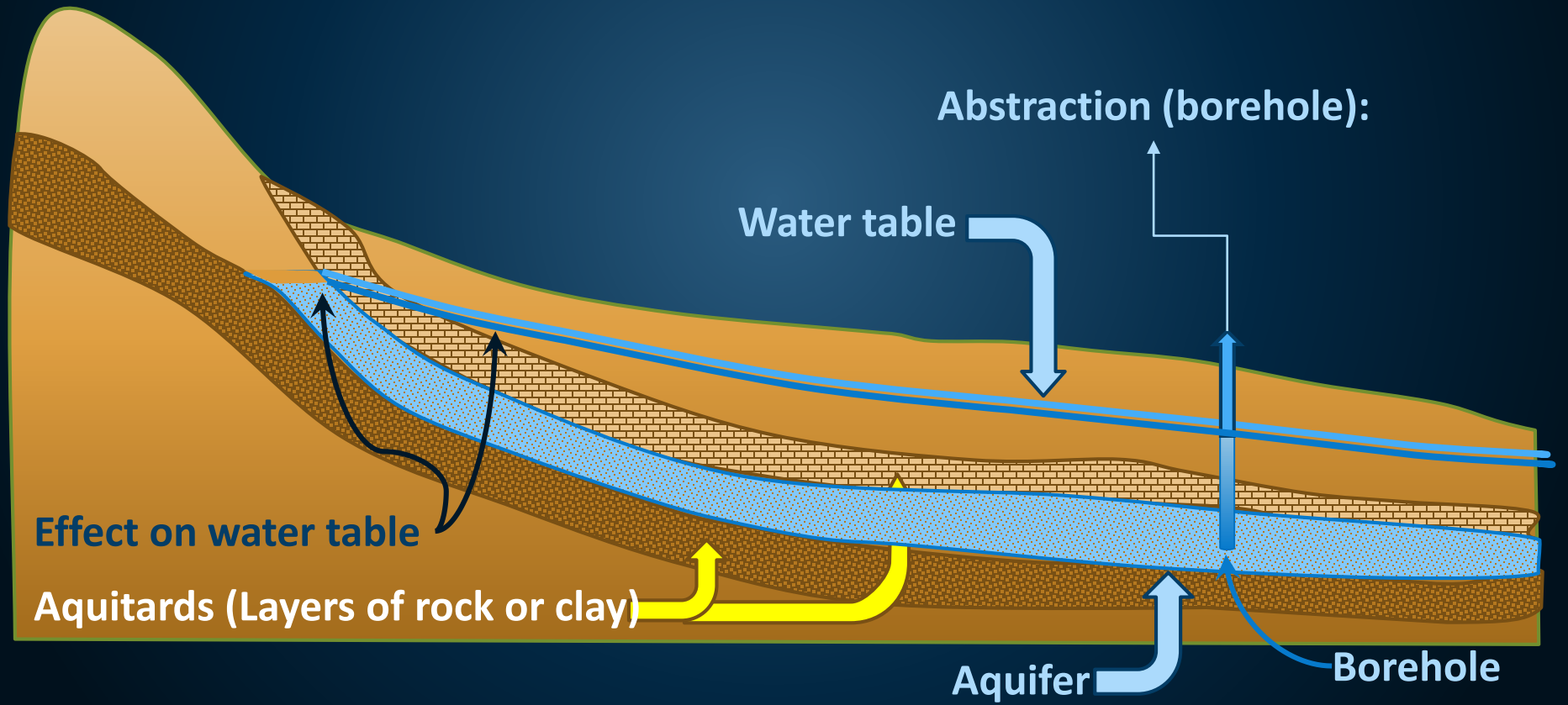
Confined Aquifers

Where an aquifer is overlain by a layer of rock or clay (aquitard) that may hold some groundwater but is not porous enough to allow water to flow through it, it is known as a confined aquifer.



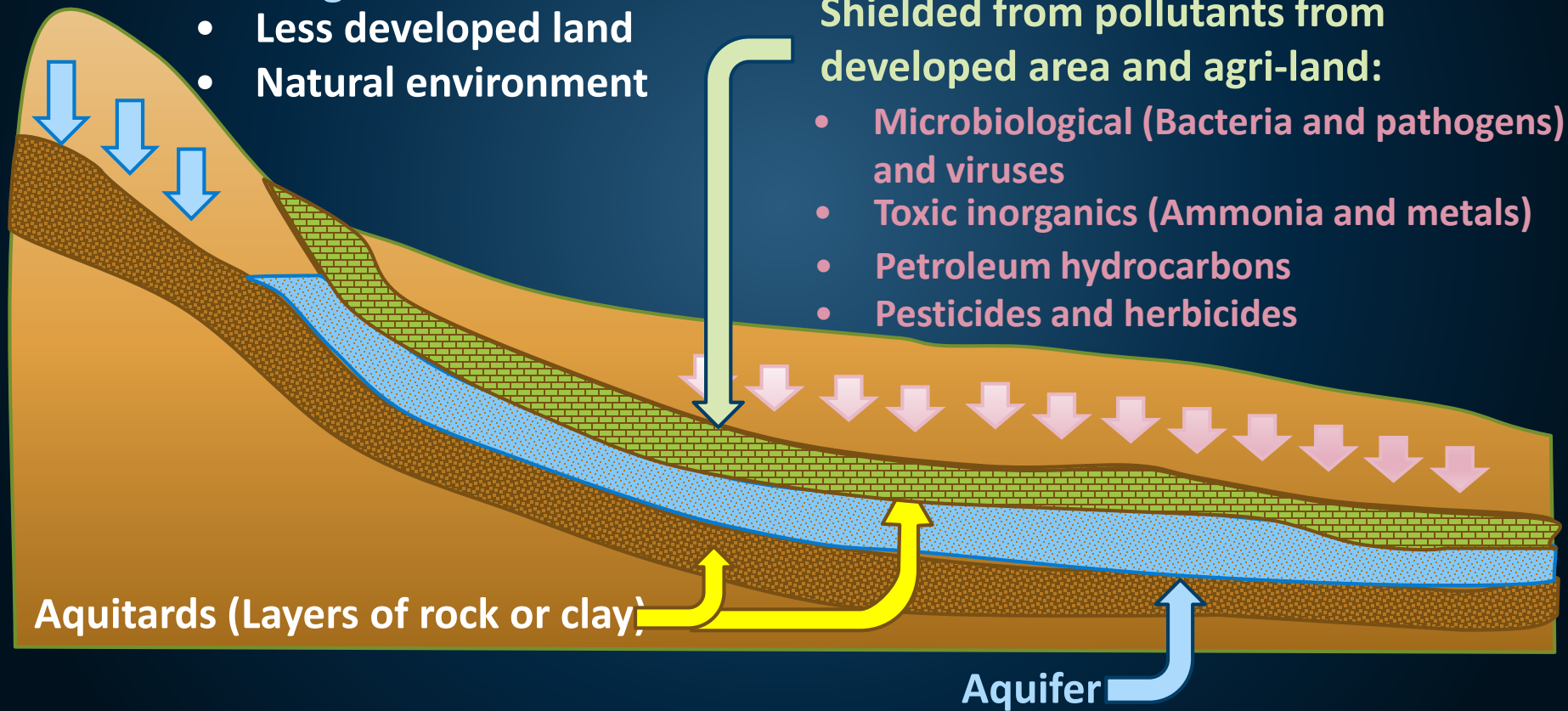
Confined Aquifers

Abstraction from a confined aquifer (borehole).



Confined Aquifers

Water Quality



Cape Flats Aquifer

The Cape Flats Aquifer is an unconfined (open) aquifer!

Recharged from surface water runoff:

- Residential
- Industrial
- Agricultural
- Outflows from sewage plants

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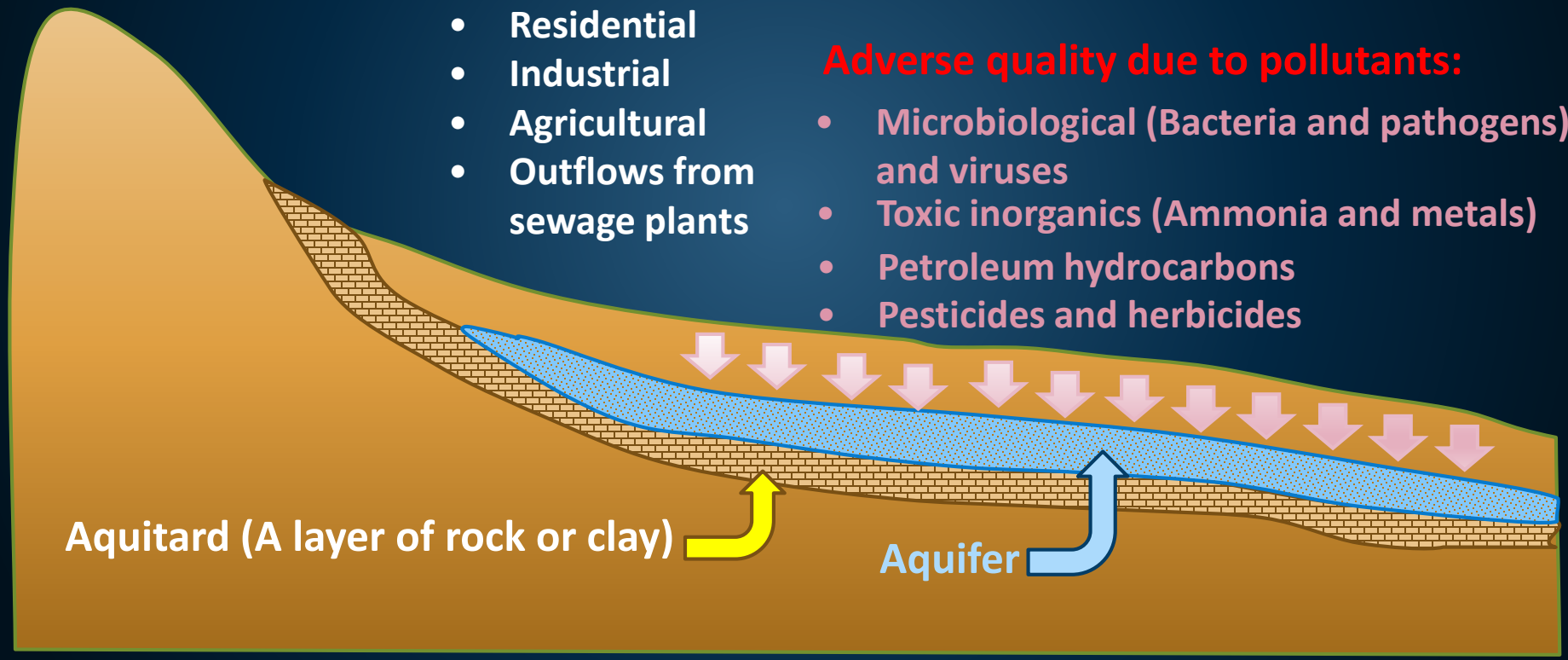


Groundwater Abstraction: Implications

The volume estimated to changed over months – reduced to 35 000 m^3/day:

Abstraction cannot be from one point

A labyrinth of new pipelines with pump stations will be required for collection at one/few points before transferring to an existing WTW – given the highly dense built-up area on the Cape Flats

Groundwater Abstraction: Implications

Quality of the Cape Flats aquifer:

Due to the deterioration of ground water quality, significant upgrades at the current WTW will be required (for advanced treatment processes)

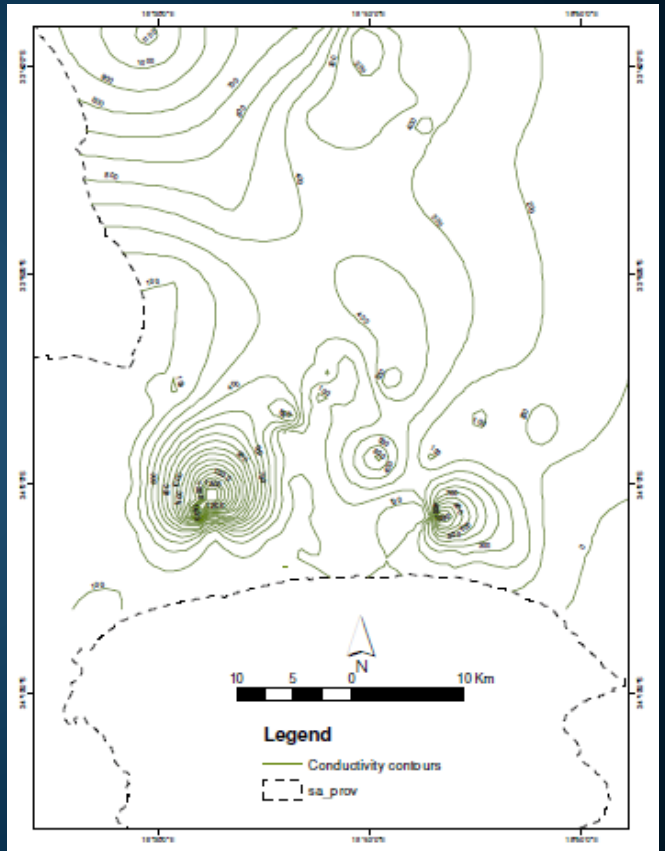
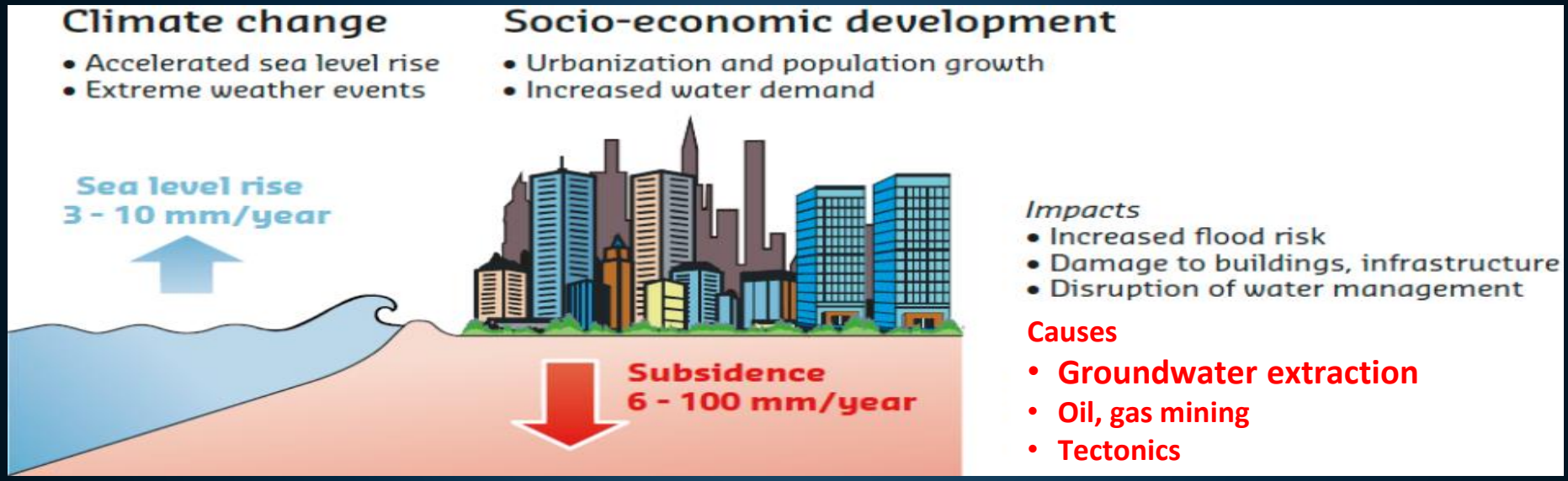


Figure 14
Water quality map based on electrical conductivity distribution in the Cape Flats

An example of the spatial variation of water quality in the Cape Flats
(Water SA vol.36 n.4 Pretoria Jul. 2010.)

Groundwater Abstraction: Implications

The SINKING Coastal Cities of the World



Sinking coastal cities

G. Erkens, T. Bucx, R. Dam, G. de Lange, and J. Lambert

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Groundwater Abstraction: Implications

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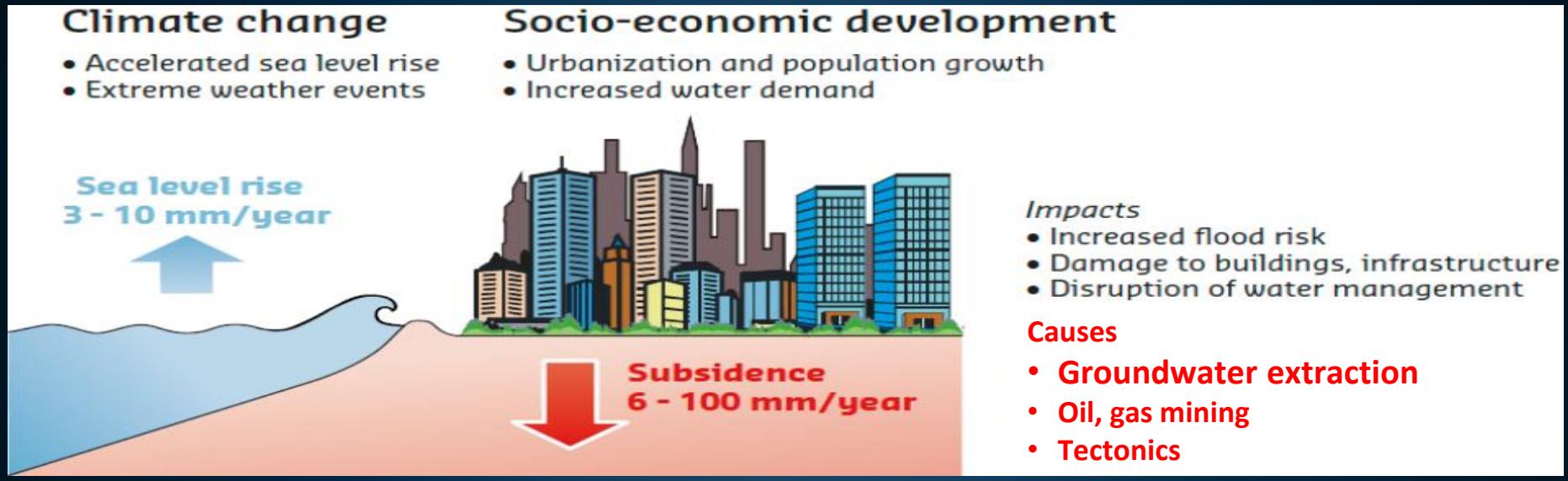

New Orleans, Louisiana, US

14.5 inches of sea level rise by 2040

Groundwater pumping and dewatering are believed to be the primary reasons.

Groundwater Abstraction: Implications

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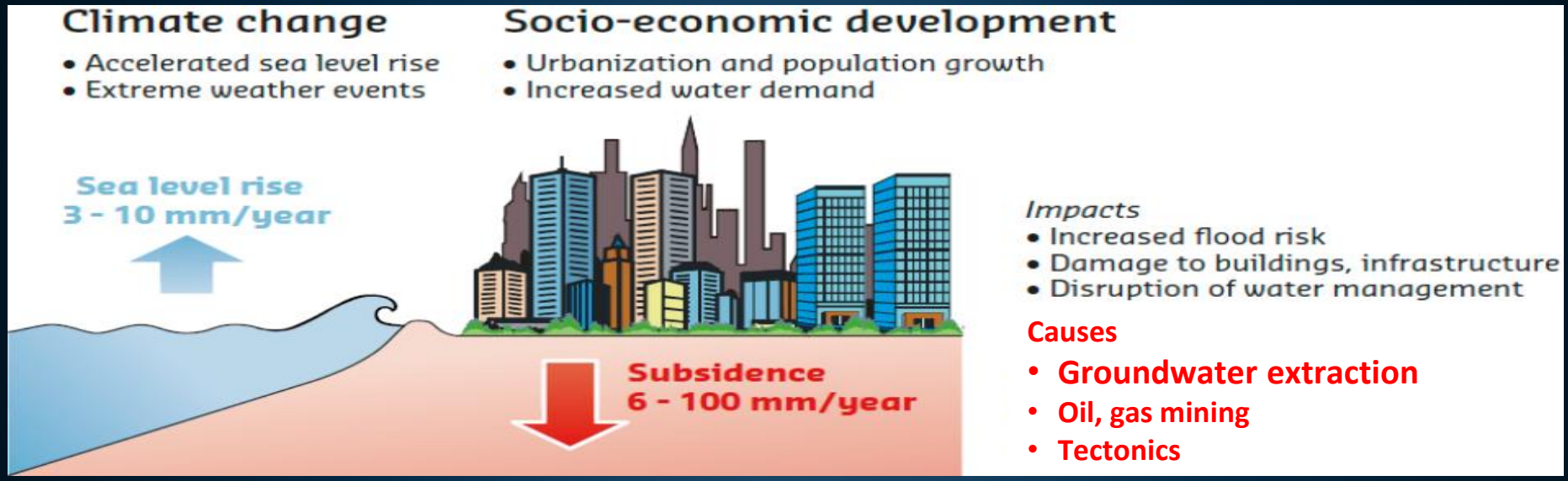

Tokyo, Japan

Up until the 1960s, the city was sinking by almost 4 inches every year. The rate went down after regulations were imposed on groundwater use.

Groundwater Abstraction: Implications

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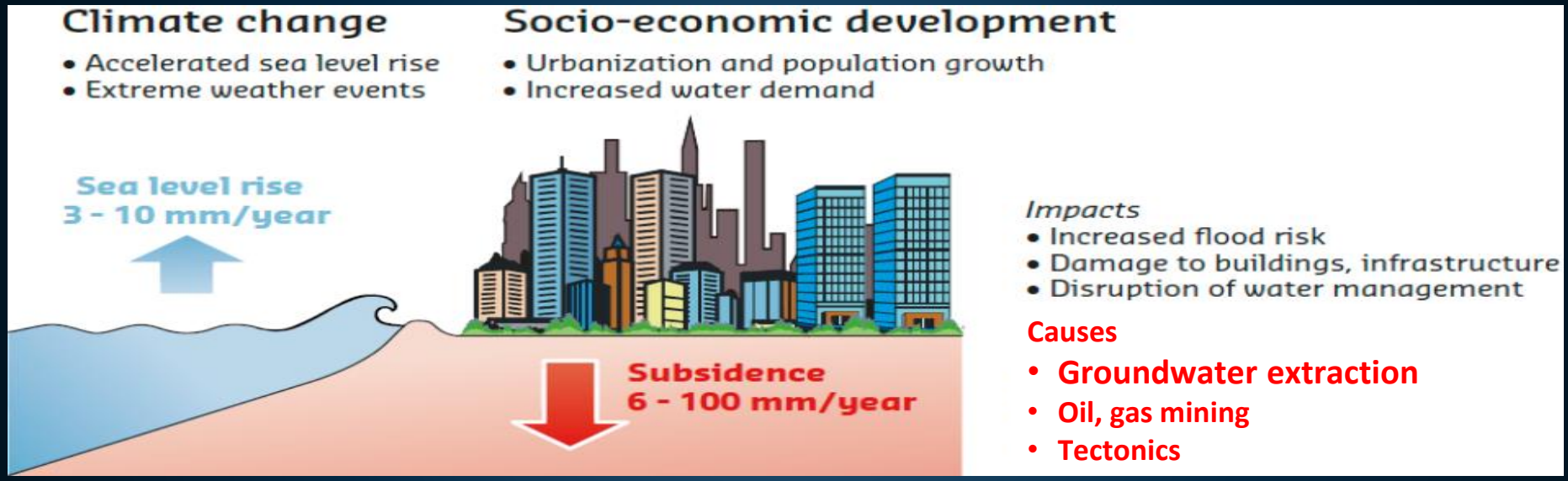

Ho Chi Minh City, Vietnam

Many parts of the city are sinking by 0.2-0.4 inches per year.

The main reasons cited were over-exploitation of underground water

Groundwater Abstraction: Implications

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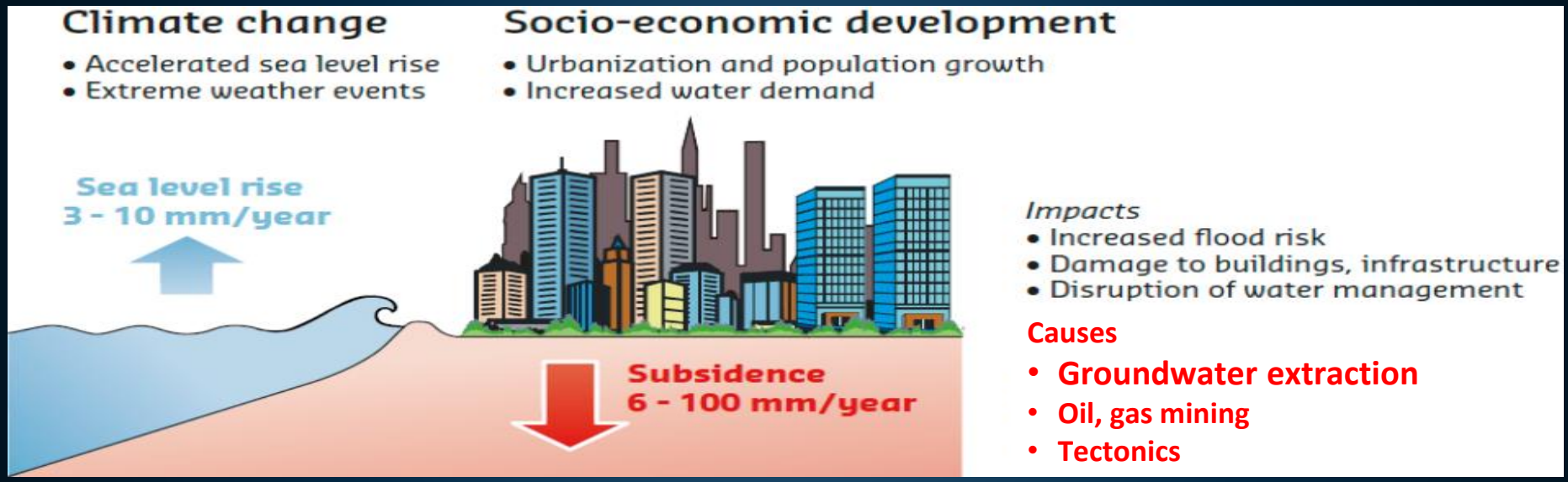

Dhaka, Bangladesh

The city has been sinking due to extensive groundwater extraction, leading to increased flooding.

Groundwater Abstraction: Implications

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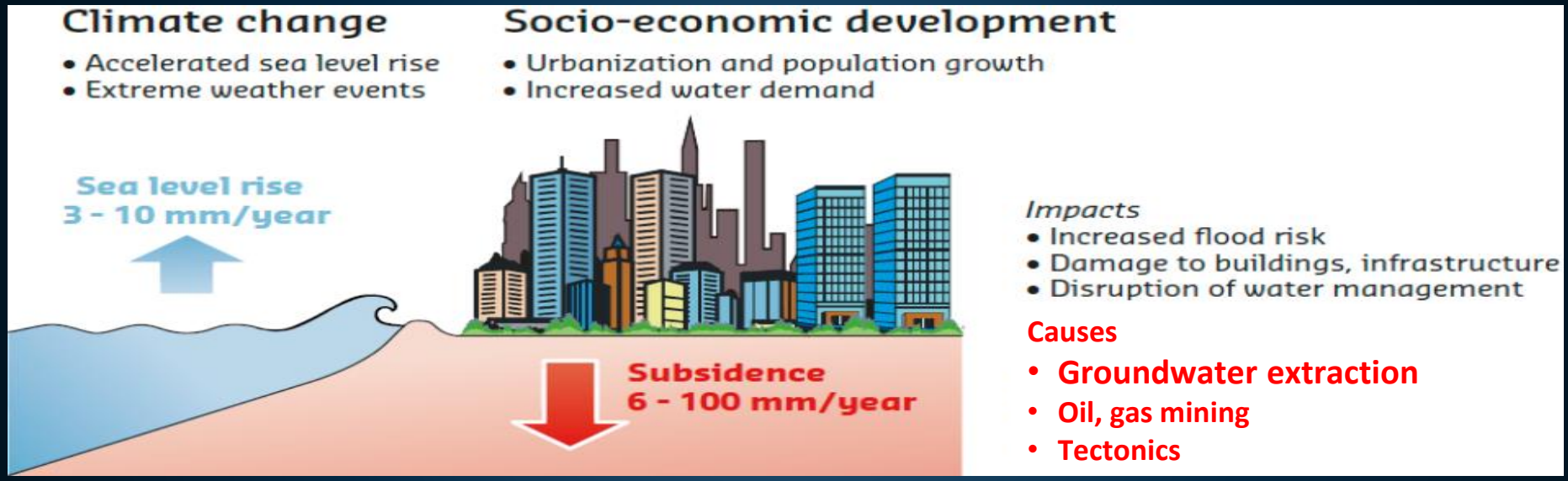

Shanghai, China

In the last 100 years, the country's biggest city has sunk by over 2.5 meters due to pmping of groundwater.

Groundwater Abstraction: Implications

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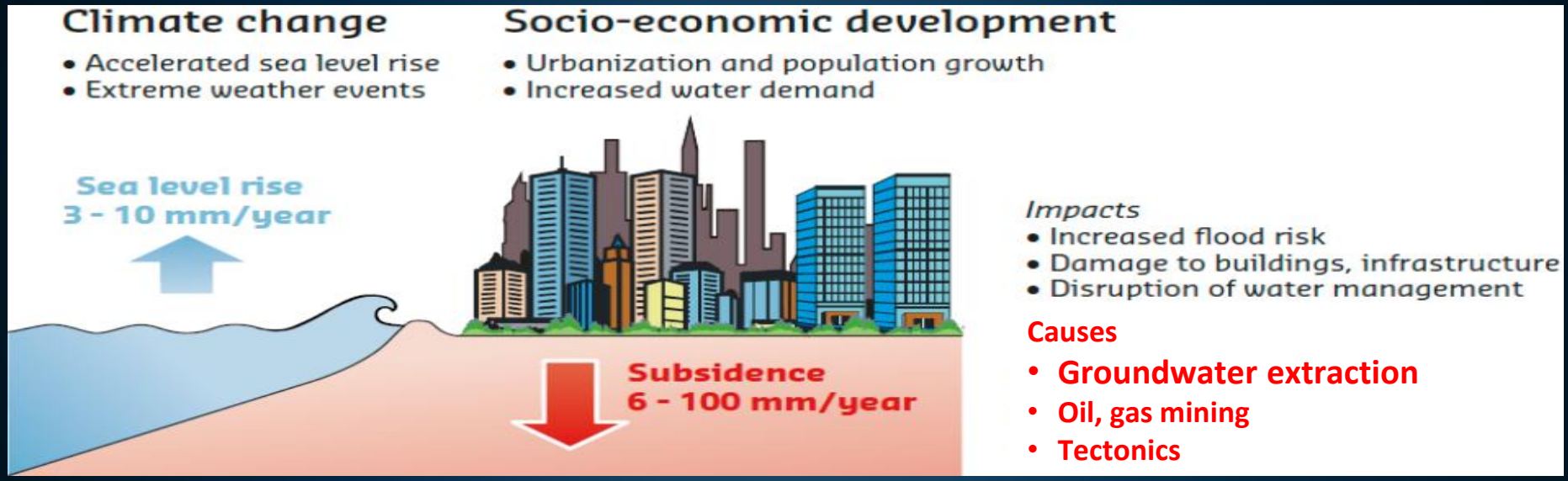

Manila, Philippines

The capital city is sinking by about 4 inches each year due to over-pumping of groundwater.

Groundwater Abstraction: Implications

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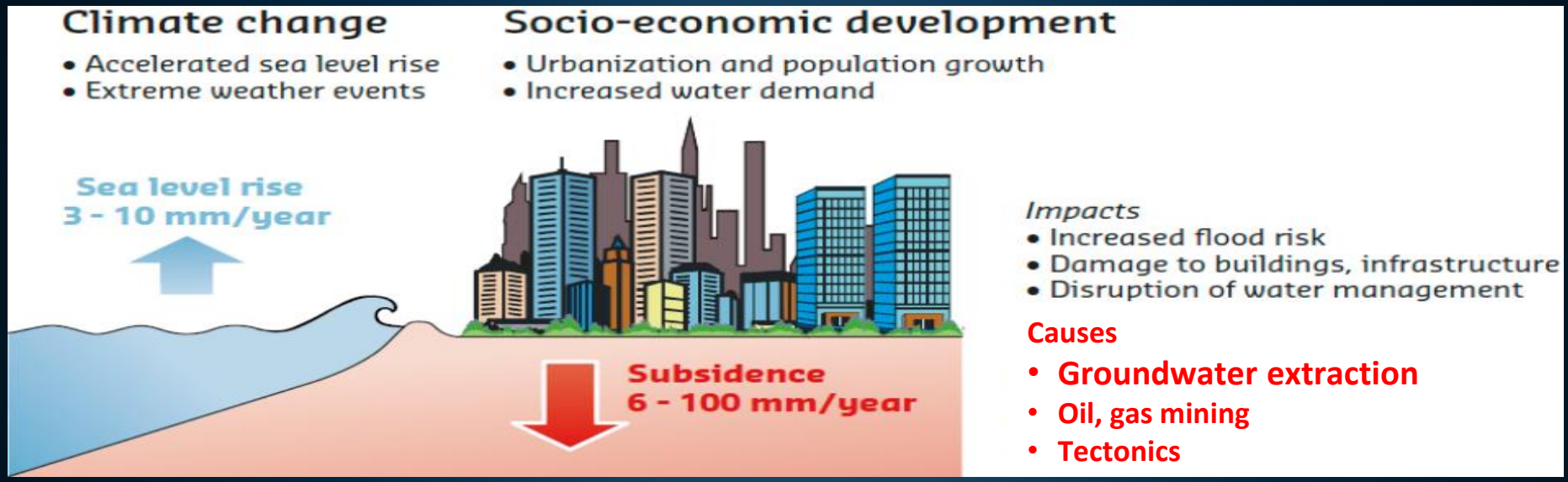


Jakarta, Indonesia

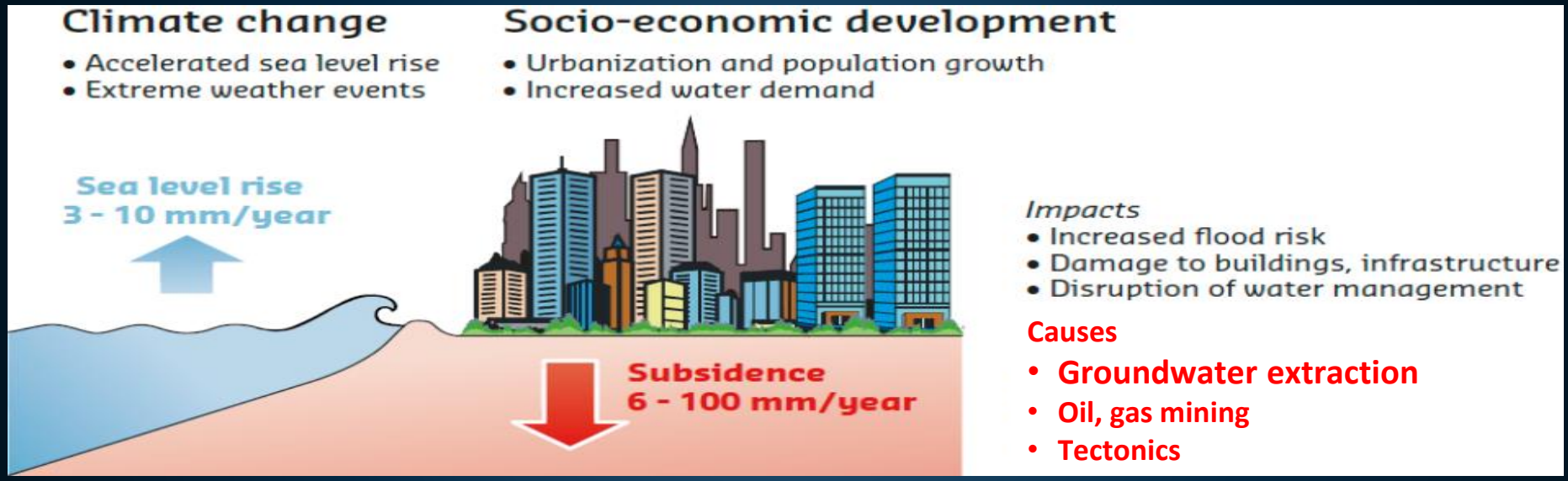
One of the fastest sinking cities in the world (9.8 inches/year)

The main reason - residents rely heavily on wells

extracting water from aquifers.

Groundwater Abstraction: Implications

The SINKING Coastal Cities of the World



Houston, Texas, US

Extensive extraction of groundwater and oil have led to the city sinking by around 2 inches per year.

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