

## Lecture 6 summary:

### Economics, risk, uncertainty and environmental analysis.

#### 2.11. Economics, Risk and Uncertainty Analysis

Economic analyses are an essential aspect of a reservoir management.

##### - CAPEX and OPEX

Capital expenditures *CAPEX* include the cost of facilities such as offshore platforms and pipelines.

Operating expenses *OPEX* include on-going expenses such as salaries and maintenance costs.

##### - Risk and Uncertainty Analysis

Despite the information about a natural resource is usually incomplete, but we must often make important decisions to advance a project.

These decisions should be made with the recognition of the risk, or uncertainty.

Risk: the possibility that can adversely affect the value of an asset.

Uncertainty: the concept that we can not predict our decisions with 100% accuracy.

Risk analysis is an attempt to quantify the risks associated with investing under uncertainty.

#### 2.12. Environment

Environmental issues must always be considered in the development of a reservoir management strategy.

A well managed field should be compatible with both the surface and subsurface environment.

The advantages of operating a field with prudent consideration of environmental issues can pay economic dividends.

Environmental issues can minimize adverse environmental effects that may require costly remediation and financial penalties.

Failure to consider environmental issues adequately can lead to both tangible and intangible losses.

### **- Global Climate Change**

The increase in the average temperature of the Earth's atmosphere has been linked to the combustion of fuels.

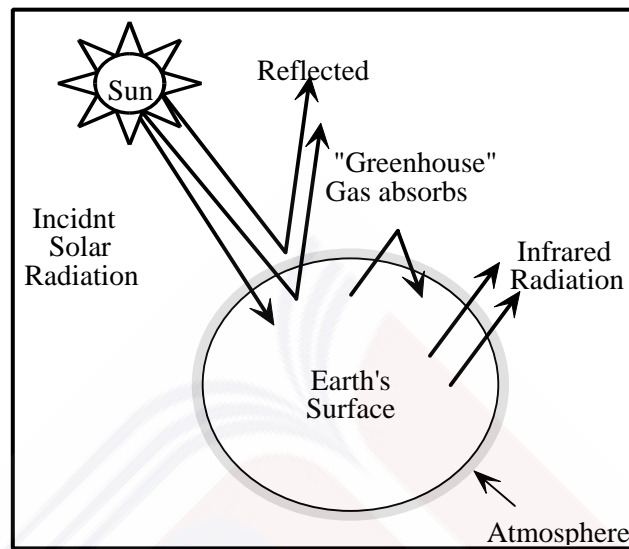
carbon can react with oxygen and nitrogen in the atmosphere to produce carbon dioxide ( $\text{CO}_2$ ), carbon monoxide, and nitrogen oxides.

Some of the solar radiation from the Sun is absorbed by the Earth, some is reflected into space, and some is captured by greenhouse gases in the atmosphere and reradiated as infrared radiation (heat). The reradiated energy would have escaped the Earth as reflected sunlight if greenhouse gases were not present in the atmosphere. Greenhouse gases include carbon dioxide, methane, and nitrous oxide, as well as other gases.

The Kyoto Protocol is an international treaty that was negotiated in Kyoto, Japan in 1997 to establish limits on the amount of greenhouse gases a country can emit into the atmosphere.

Industry is considering options for addressing the climate change issue. One of the leading options is to collect and store  $\text{CO}_2$  in reservoirs in a process known as geologic carbon sequestration. The goal of geologic carbon sequestration and similar programs is to provide economically

competitive and environmentally safe options to offset all projected growth in baseline emissions of greenhouse gases.



**Figure 15. The Greenhouse Effect**

### **- Subsidence**

Subsidence is a compressibility effect that depends on the geo-mechanics of the produced interval and its overburden.

The reservoirs with large lateral dimensions relative to their vertical thickness deform mainly in the vertical direction.

In many cases, subsidence has little or no adverse environmental effects. In some cases, however, subsidence can be a significant concern.

Pressure maintenance program can help avoid damage caused by surface subsidence.

Subsidence has been responsible for earthquakes in areas such as the Rocky Mountain Arsenal near Denver, Colorado.

Development activities in tectonically active areas need to anticipate the impact of subsidence and production induced seismicity as part of their reservoir management plans.