## **Elements of Water Security**

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### Global Precipitation changes 1990 - 2090



Figure 2.10: Large-scale relative changes in annual runoff for the period 2090–2099, relative to 1980–1999. White areas are where less than 66% of the ensemble of 12 models agree on the sign of change, and hatched areas are where more than 90% of models agree on the sign of change (Milly et al., 2005). [Based on SYR Figure 3.5 and WGII Figure 3.4]

## The Climate Moisture Index, representing climatically-induced water variability



## **Elements of water security**

### **Diverse uses of water**

- Human well-being health, food security
- Economic development (energy, industry)
- Social development
- Water to sustain ecosystems

### Water as a threat

- Floods
- Droughts
- Pollution

### Basic Human Wellbeing – water for health and food security







## Ataturk dam, Euphrates River, Turkey



## **The Energy Linkage**





**Social development** 

- The need for education - The effects of lack of drinking water and sanitation on education

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## Water for natural ecosystems





## FLOODS AND DROUGHTS





### Water as a threat:

- Floods from the land
- Storm surges, tsunamis from oceans





### **Regions of stress**



# Canada – elements of water security in a land of snow and ice

- Ice-jam floods
- Global warming more pronounced in high latitudes and high altitudes
- Permafrost retreat
- Mountains as water towers of snow and ice
- The effects of shorter winters
- The effects of glacier retreat



# Polar ice coverSept 2001Sept 2007





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1 12 05



1 02 06











## **Permafrost thaw**



## Ice roads – the effects of early break-up



Western Canada

### Annual Precipitation

### **Annual Snowfall**



## Rockies in winter





Average change (days/yr) in snow cover duration in the second half (Feb.-Jul.) of the snow year over the period 1972-2000.

Derived from the NOAA weekly satellite snow cover dataset

### The importance of mountains as 'Water Towers'



### High inter-annual variability in precipitation



### Athabasca (photo: D Latimer)



## Peyto Glacier 2001

1966

Neoglacial maximum ca. 1840



#### Annual Bow River (above Banff) Basin yield with glacier wastage and storage super-imposed



#### Observed monthly hydrograph for Bow River above Banff 1969-1972 with modelled

wastage flow super-imposed



## Thank You