Sea Level Change: Anthropogenic TWS Contributions



model



Groundwater Pumping Scheme

Surface Water



A thick bottom layer (90m) is added that acts as a deep groundwater aquifer and serves as a <u>source of</u> <u>water for pumping</u>



Unsaturated Soil: P + I - ET - R_{gw} - Q_s = 0

 $\frac{Groundwater Aquifer:}{R_{gw} - GW_{pt} - Q_{gw} = S_{\gamma} \cdot \Delta S / \Delta t}$ $R_{gw} = G_{f} - C_{f}$

 $-Q_{s} = 0$ Aquifer: $gw = S_{v} \cdot \Delta S/\Delta t$ $f_{gw} = S_{v} \cdot \Delta S/\Delta t$

The first fully integrated Surface Water / Groundwater / Human Impacts model within the framework of global LSM

Yadu N. Pokhrel, Oki Lab. IIS

Global Groundwater Depletion



✓ Both withdrawal and recharge are simulated

✓ Groundwater depletion is estimated as the difference of withdrawal and <u>recharge</u>



Global total

~370 km³

~290 km³

Groundwater Use: Validation in US Aquifers



Almost <u>30%</u> of GW <u>withdrawals for irrigation</u> in the US. <u> \sim 97%</u> of <u>GW withdrawals</u> from the aquifer are used for irrigation.



4 Irrigation Pumping and Groundwater Depletion

Yadu N. Pokhrel, Oki Lab. IIS

Groundwater Depletion (High Plains Aquifer)







Figure 2. Cumulative change and total ground water in storage in the High Plains aguifer, predevelopment to 2007 (modified from McGuire, 2006)

USGS reports considerable decline in groundwater storage/levels in recent

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Irrigation Pumping and Groundwater Depletion





Remarks

- Integrated model of natural hydrology & anthropogenic activities is under development.
 - Capable of assessing the source and path of water withdrawals for agricultural productions
 - ***** Monitor the non-local/non-renewable water usages
- Human activities are changing the hydrological cycles even on global scale:
 - Storing in artificial reservoirs, exploiting fossil ground water, and the changes terrestrial water storages are changing the sea level.

IPCC AR5 WGII Ch3 "Freshwater", 1st Lead Author Meeting, Tsukuba, Japan, Jan.2011



Working Group II Climate Change Impacts, Adaptation and Vulnerability INTERGOVERNMENTAL PANEL ON Climate change

Working Group II calendar

- LAM1:
- Informal Peer Review:
- LAM2:
- Expert Review:
- LAM3:
- Government & Expert Review:
- LAM4: Literature cutoff (in press) FGD
- Final Government Distribution:
- Plenary:

January 2011 ZOD July - September 2011 December 2011 FOD June - August 2012 October 2012 SOD March - May 2013 July 2013 October - December 2013 March 2014

AR5/WGII Chapter 3 "Freshwater Resources" Taikan Oki (taikan@iis.u-tokyo.ac.jp), CLA





Announcement

- Domestic meeting preparing for the Belmont forum/Grand Challenge WS on Water Security #with delegates from MEXT
- **Date: Friday, October 21st, 2011**
 - **Time: 11:00-17:00**
- Place: Institute of Industrial Science
 - ***Komaba II Research Campus, The U of Tokyo**
- **Contacts:**
 - *****Taikan Oki (taikan@iis.u-tokyo.ac.jp)
 - Makoto Taniguchi (makoto@chikyu.ac.jp)

飲水思源 When you drink water, think its origin.

飲食思水 When you eat, think about water.

饮水区,禁止污染! Drinking water part No pollution !

Thank You!







Sea Level Change: Anthropogenic TWS Contributions

Source	Sea Level Rise (mm yr⁻¹)	
	1961–2003	1993–2003
Thermal Expansion	0.42 ± 0.12	1.6 ± 0.5
Glaciers and Ice Caps	0.50 ± 0.18	0.77 ± 0.22
Greenland Ice Sheet	0.05 ± 0.12	0.21 ± 0.07
Antarctic Ice Sheet	0.14 ± 0.41	0.21 ± 0.35
Sum	1.1 ± 0.5	2.8 ± 0.7
Observed	1.8 ± 0.5	
		3.1 ± 0.7
Difference (Observed –Sum)	0.7 ± 0.7	0.3 ± 1.0

IPCC-AR4: "We conclude that the budget of sea level has not yet been closed satisfactorily closed ... anthropogenic contributions from terrestrial water storage are poorly known and are omitted in the current assessment..."

Can this gap be partly filled by anthropogenic TWS cont

Very few studies exist:

- ✓ Chao et al. (2008) estimated reservoir impoundment contributions to sea level change, <u>but the maximum</u> <u>capacity of reservoirs was considered</u>
- ✓ <u>Actual reservoir storage</u> = ??
- Comprehensive estimation of direct anthropogenic TWS contributions to SLC is <u>not available</u>



Yadu N. Pokhrel,

