Future land use maps including water restrictions and socio-economic opportunities

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Introduction

- irrigated area has doubled since 1960
- Water use has tripled and outpaced human population growth rate
- Irrigated production supply 40% of our food
- Some rivers do not reach the sea anymore (Colorado, Nile, Indus)
- 35 % loss of river species worldwide (Loh et al., 2010)

Environmental flow requirements (EFRs) and water availability were almost always neglected in land-use scenarios (Alcamo, 2003 ; Gerten, 2013) or defined in a very simplistic way: fixed threshold of annual flow (Vorosmarty, 2010; Smakhtin, 2004).

A New environmental flow method was developed in 2014, the Variable Monthly Flow (VMF) and was implemented in the Global Biosphere Management model (GLOBIOM, Havlik et al., 2014) to design new sustainable land-use repartition of agriculture land including rainfed and irrigated areas (Figs. 1, 2 and 3; Table 1).

Material and method

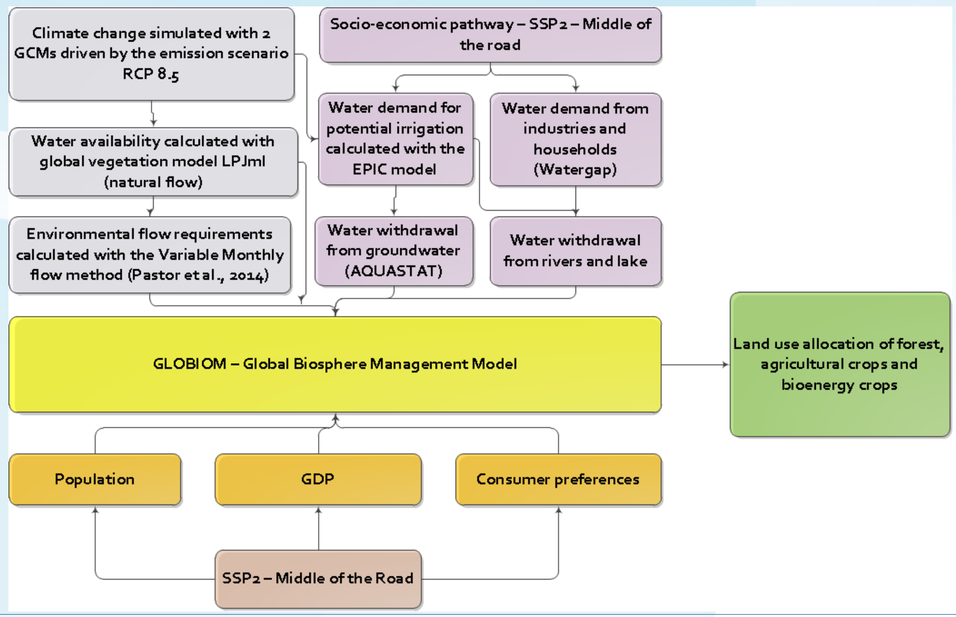

Fig. 1: Conceptual framework of designing new land-use maps with GLOBIOM

Scenarios

	Climate change 2050 (2GCM2 – RCP8.5)	Water demand 2050 (EPIC – watergap)	Water restrictions at LU level	Environmental Flow Requirement level (VMF method)
Baseline 2000	2000	2000	-	-
BAU_2050	x	x	-	-
BIO_2050	*x*	*x*	*x*	-
VMF_2050	X	X	X	X
VMFhigh_2050	X	X	X	X (+50%)

Table 1: scenarios selected to design new land-use map

Results and discussion

- Strong signal from both GCMs that water availability will decrease in Brazil, China, South-east Asia and in Mediterranean and middle-east regions.
- Without EFR implementation, irrigation expansion is likely to decrease by more than 20% (+50Mha) and with EFR implementation, irrigated area is likely to decrease by up to 32% (-70Mha; Fig. 4).
- The increase in food demand would require more than 150Mha.
- Depending on EFR implementation, the ratio of irrigated/rainfed area is likely to change from 0.35 (in both scenarios Baseline and BAU_2050) towards 0.17 with VMFhigh_2050 scenario (Fig. 5).
- Global impact of implementation is not substantial however, local impacts and shift of agriculture land and crops are substantial (maize, sugarcane area increase vs. wheat production; data not shown).

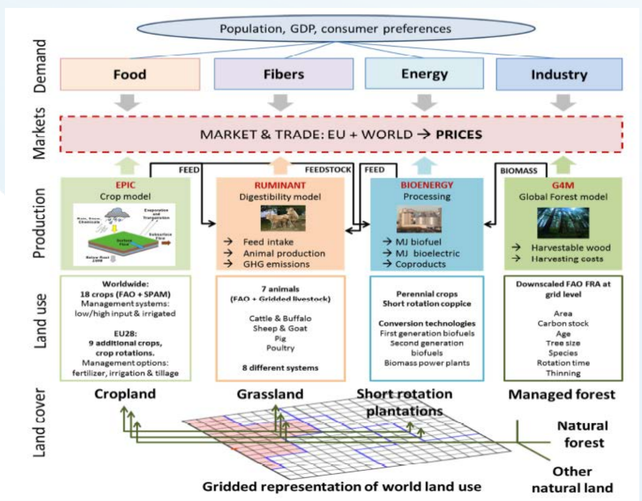

Fig. 2: Conceptual diagram of the Global Biosphere Management Model (GLOBIOM)

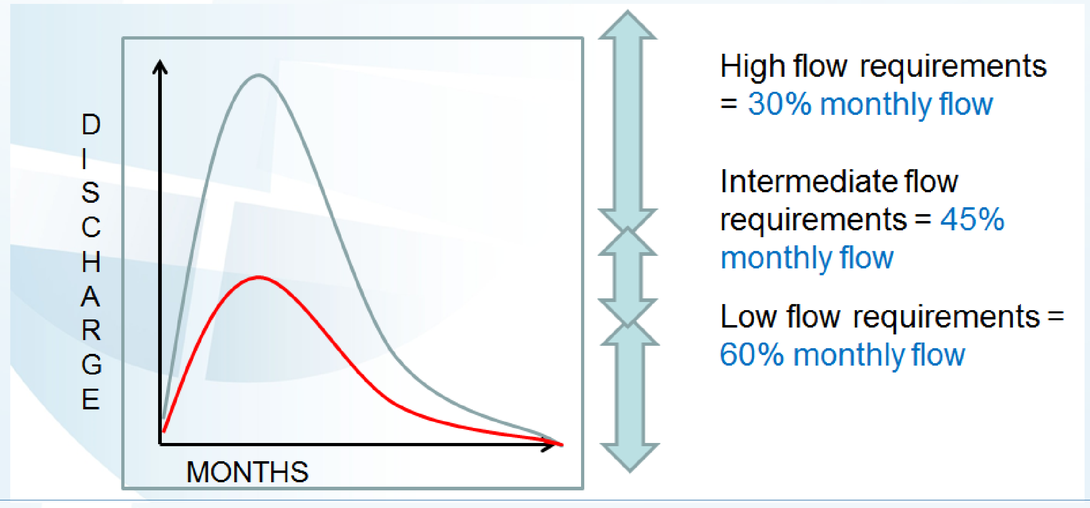

Fig. 3: Environmental flow requirement method: the Variable Monthly Flow (VMF) method (Pastor et al. 2014)

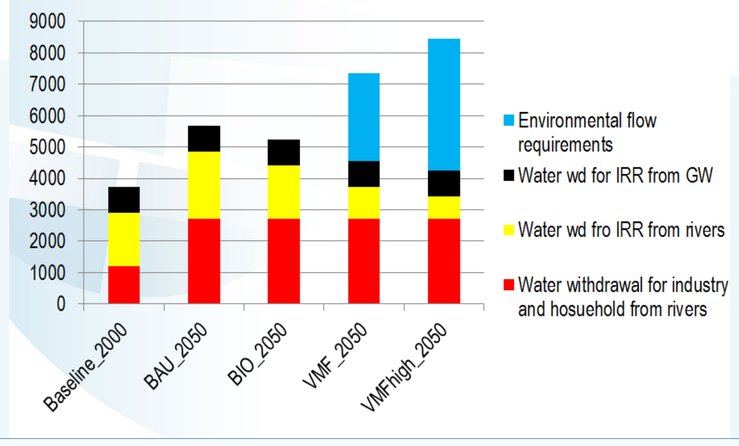

Fig. 4: Global water use prediction with EFR implementation by 2050 (km^3 $year^{-1}$)

Source: http://allianceforwatereducation.org/why-its-urgent/6-reasons-why-you-need-to-know-about-water-right-now/

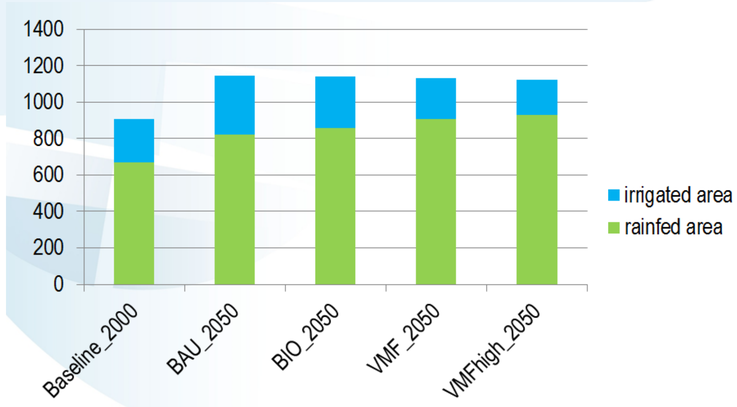

Fig. 5: Global agriculture land expansion with EFR implementation by 2050 (Mha)

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