Water Stress Indicators: A Comparison of Geographic Models and their Relevance to the European Union's Migrant Crisis

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Three years ago I read the book Out of Poverty by Paul Polak. In the book Polak describes his work to bring affordable treadle pumps and drip irrigation systems to the rural poor in Bangladesh, Cambodia, India, and Zambia. With these new tools, the farmers grow and sell higher-value fruits and vegetables. "This is great" I thought, but then it struck me: where is all of this water coming from? And more importantly, how long will this increased water use be sustainable?

Water stress has been modeled for decades, most commonly in terms of the Falkenmark Indicator (Falkenmark, 1989). The Falkenmark indicator measures freshwater availability in cubic meters per capita per year and categorizes water stress as shown in Table 1.

Table 1. Water stress indicator as proposed by Falkenmark, 1989.

Index (m^3/capita/year)	Stress Level
>1,700	No Stress
1,000-1,700	Stress
500-1,000	Scarcity
<500	Absolute Scarcity

Unsurprisingly, the popularity of the Falkenmark Indicator (due to its ease of computation and application) is subject to modeling imperfections due to oversimplifications of water use. Many engineers and scientists have proposed different systems for measuring water stresses, all of which have been summarized by Brown & Matlock, 2011 as follows:

- Indices Based on Human Rights
- Water Resources Vulnerability Indices
- Indices Incorporating Environmental Water Requirements
- Life Cycle Assessment and Water Footprint

In my term project it is my intent to compare these different models in order to better understand the differences and their implications on present and future water stress projections. I plan to use my developing knowledge of GIS to create maps describing water stresses throughout the world (the geographic area that I am dealing with may become confined only to the US and/or the EU in order to make the scope of work manageable, especially considering the availability of data in these countries). Ideally I will be able to map what the current stresses are (using the different models) and compare each model to the other models for both present and future projections.

Time permitting (and assuming the relevant data exists) I would like to compare water stresses to water usage and population growth. I am particularly interested in what a future timeline looks like assuming business as normal: I would like to develop some form of map that projects the years that different geographic areas will deplete their water supplies. A relatively detailed and recent area of interest is in the EU migrant crisis: **I would like to model and understand what the European Union's new demand on its water supplies (including domestic, industrial, agricultural, etc.) will be with the increased population growth caused by the migrants claiming asylum, and I would like to project how that changes the future projections of water sustainability throughout the EU**. For example: if Germany currently anticipates water stress arriving in the year 2100, how will the population influx of migrant effect this projection?