Example of a stakeholder-driven evaluation and prioritization of potential adaptation strategies for water scarcity

Context: semi-arid ecological zone experiencing more frequent, prolonged droughts. The impact on rural people of this uncertainty in precipitation and subsequent water scarcity is made more severe by the predominance of water-intensive agricultural livelihoods. Agriculture here is mainly rainfed, so the climate change being experienced is leading to severe food shortages in dry years, which are becoming more frequent.

1. **Identify Key Vulnerability (or vulnerabilities):** (Identified by consultation with stakeholders, *facilitated using MCA-WEAP.*) Uncertainty of access to water to grow food due to changing patterns of precipitation.

2. **Identify Potential Adaptation Strategies** (Identified, in part, by consultation with stakeholders; *facilitated using MCA-WEAP*):

   (a) Rain harvesting and storage in small reservoirs - collecting the water and storing it for use in dry periods has widespread appeal by farmers and local businessmen (high consensus).

   (b) Rain harvesting and storage in aquifer - again, storing water for use in dry periods has appeal from farmers and local businessmen, but farmers have never heard of doing such a thing and worry about "harming" the aquifer (mediocre consensus).

   (c) Water Conservation Initiative Measure by implementing drip irrigation method - Farmers are reluctant to try new method, but local businessmen are eager to sell them the equipment needed. (disagreement)

   (d) Promote alternative livelihoods for farmers. Farmers very reluctant to give up farming and move to the city for other livelihoods. Businessmen will also lose their businesses because they will have no customers. (high consensus)

   Note: each of these adaptation strategies will be subsequently analyzed as a scenario in WEAP (see step 4 below).

3. **Identification of Criteria to evaluate strategies**: (Also in consultation with stakeholders in addition to expert knowledge, *facilitated with MCA-WEAP*):

   (a) Cost to implement strategy (emphasized by the farmers because they will bear the cost through taxes and purchase of equipment). *Unit of measure = monetary*.

   (b) Sustainability of strategy (farmers will want stability in their lives, and by businessmen want long term customers). *Unit of measure = useful life of reservoir or equipment (years), crop yield increases (metric ton?), magnitude of pollution generated by alternative livelihoods (volume of water polluted in m^3).*

   (c) Does strategy lead to greater access to water (emphasized by farmers in particular). *Unit of measure = volume of water made available.*

   (d) Does strategy preserve agricultural way of life, which is highly valued by the farming community (highly emphasized by farmers, but business don't care as long as someone is around to buy their products. However, the businessmen don't realize that the farmers will likely have to move to the city to get jobs). *Unit of measure = personal valuation.*

   Note: these criteria do not have the same units of measure, sometimes even varying by the strategy for a given criteria. Other criteria are not even readily quantifiable, or thought of in terms of 'numbers', such as the social value attributed to working the land. One way to deal with this issue is to 'normalize' each criterion to a relative scale- perhaps giving it an 'intensity' from 1 to 5, with 1 being very low and 5 being very high (for the cost to implement a strategy, a high cost would be given a value of 5, for example).

4. **Information gathering phase** (done by experts, *uses WEAP*):

   (a) obtain costs to build dams, buy drip irrigation equipment, etc.; determine if it is feasible for farmers to have economic success with alternative livelihood and still remain in rural area (see Table 1 below).

   (b) run hydrology/planning model (such as WEAP) to obtain data on water savings and availability under different strategy scenarios (see Table 1 below).

5. **Return to stakeholders with results of analyses**: purpose is to let stakeholders review the results (Table 1) and reevaluate their preferences through assigning weights to criteria now that they have information (indicators) to support these criteria - information obtained through data collection and modeling. Data obtained by the WEAP model appears in red in Table 1.

Note: The linkage between WEAP and the multi-criteria analysis tool MCA-WEAP is not explicit, in that the two tools are NOT formally 'connected'. Information and results obtained from WEAP simulations are merely used to inform the stakeholder consultation on impacts/effects of particular adaptation strategies. The MCA-WEAP tool then is used in the consultation process to eventually determine the prioritization ranking of preferred adaptation strategies.

Through group consultation, stakeholders now assign (or revise) the *weighting* for the criteria based in part on consideration of this new information (obtained by the modeling and obtaining the cost information) they did not have in the initial consultation, and these data are input into MCA-WEAP. These weighting factors describe the relative weight that a single criteria will have in determining the final 'score', or rank, of the adaptation strategy. For example, the stakeholders may assign the criterion of 'greater access to water for local population' as the one with the greatest weight in determining the final score.

6. Rank adaptation strategies: MCA-WEAP provides a prioritization ranking of most preferred strategies (from perspective of all stakeholders) based on the stakeholder valuation of the criteria and their relative weights.

Table 1. Results of Scenario analyses

Adaptation Strategy	Criteria for Evaluating Strategy			
	Cost to implement	**Sustainability**	**Leads to greatest access to water for the local population (measured as per capita water availability in m^3)**	**Preserves local social values to live an agricultural lifestyle**
Rain harvesting and storage in small reservoirs	high ($1.5 million required to build dam)	low *(reservoir predicted to fill with sediment in 5 years)*[a]	medium *(additional 10 million m^3 of water collected, but loss by evaporation is 35%, so net increase compared to BAU* is only 6.5 million m^3; per capita water availability rises to 250 m^3)*	high; farmer continue as they have for generations
Rain harvesting and storage in aquifer through borehole recharge	medium ($150,000 required to drill boreholes and buy pumps)	high (stakeholders maintain wells and pumps effectively, *no unmet water demand for 30 years)*	high *(additional 10 million m^3 of water collected and loss by evaporation only 5%, so net increase is 9.5 million m^3; per capita water availability rises to 350 m^3)*	high; farmer continue as they have for generations
Water Conservation Initiative Measure - Implement drip irrigation	low ($75,000 required for training in use and purchase of equipment)	high (long lifetimes for equipment, and it *increases crop yields by 20%)*	medium *(technique saves 5 million m^3 compared to business as usual; per capita water availability rises slightly to 200 m^3)*	high; farmer continue as they have for generations
Alternative livelihood rather than agriculture	very high ($5.5 million required to retrain local population and move them to urban areas, and adds an additional $7 million in cost to import food lost by local agriculture)	low *(stakeholders move to city and work in new factories opened just for them, but factories pollute the groundwater in the city, which decreases the water available there by 20%)*	very low *(stopping agriculture saves 25 million m^3 in the rural area, and alternative livelihoods in city are not water intensive, but pollution from factories decreases groundwater by 100 million m^3, so that per capita water availability actually falls to 100 m^3 from 150 m^3)*	very low; farmers are displaced to city and work in factories

[a]Data appearing in italics obtained from WEAP modeling.