Index Insurance for Climate Impacts – Millennium Villages Project

A contract proposal

As part of a comprehensive package of interventions intended to help break the poverty trap in rural Africa, the Millennium Villages Project (MVP) seeks to insure itself against adverse climate impacts by establishing an index insurance program for climate impacts.

Specifically, our proposal includes:

- Analysis and proposed index insurance contract for the Sauri sublocation in Western Kenya.
- A localized climate impacts index for drought, based on a water stress index (WRSI) of the local staple crop using nearby rain gauge data and enhanced by remotely-sensed regional vegetation greenness (NDVI).
- Index-based payouts in only the worst three drought years on record (since 1982) and no others.
- A pre-determined set of actions aimed to reduce the impact of extreme droughts that would commence when payouts are received, thereby enabling us to continue our work to achieve the Millennium Development Goals at the village level.

In summary, we feel that our index insurance product for climate impacts will be a robust tool to further manage the risk posed by extreme drought in the Sauri sublocation of the Millennium Villages Project.

Basic contract structure for Sauri, Kenya

Our proposed contract has a two-step payout structure based on pre-defined thresholds of our climate impacts index. In extreme drought years (defined as once in every 20 years, on average), the contract will pay out an amount equivalent to the costs to maintain our project interventions in the village cluster during that entire year (approximately $1.5million USD). In moderate drought years (defined as once in every eight years, on average), the contract will make a pre-specified fractional payout of approximately one-third of the full payout (about $500,000).

Using a burn analysis of hypothetical payouts based on historical rainfall and satellite data, premium for this contract is estimated to be 7.3% of liability when using a 6% price for value at risk[1].

We believe that this simplified contract structure will ease the administration of the insurance payouts (should any occur) during the first year of implementation. In the meantime, we will work to develop similar climate impacts indices and contracts for the rest of our 12 village clusters (located in 10 countries across Africa). Because of the intentional siting of our 12 village clusters in 12 different agroecological zones, we expect some balancing of risk. Our goal is to develop a project-wide insurance scheme, possibly incorporating a sliding payout system scaled with the severity of drought.

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[1] Formula used for premium calculation is: P = ave. payout + (99^{th}% loss-ave. loss) x 6%
The 99th percentile value at risk was estimated based on 22 years of data (1982-2003).

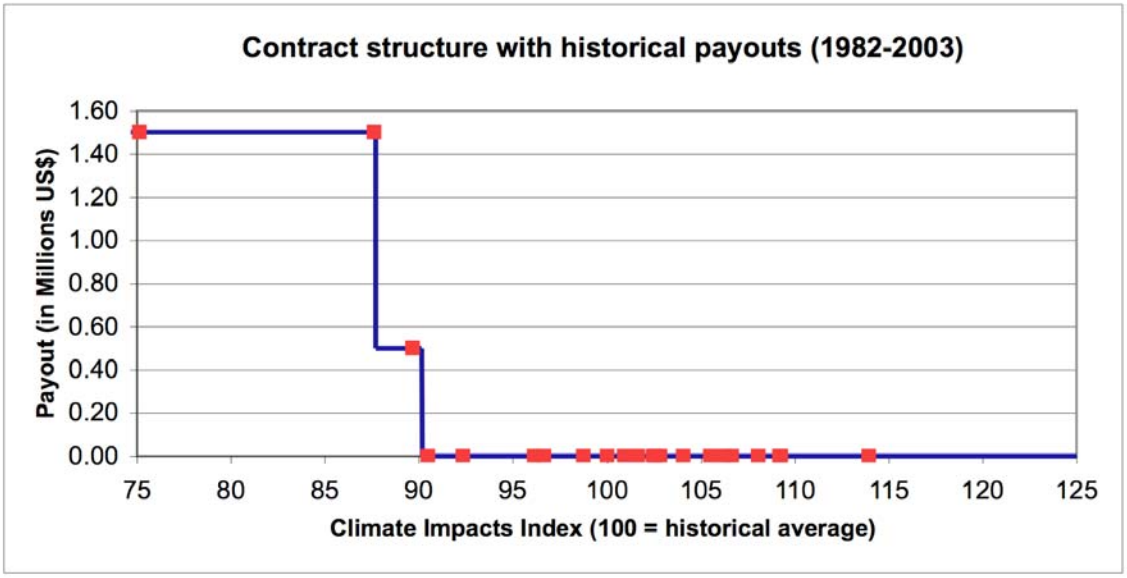

Figure 1: Contract payout structure, with a burn analysis of historical payouts.

Climate impacts index for drought

The core of our climate impacts index is generated by the transformation of daily rainfall data from a nearby weather station at Kakamega, Kenya (26km distant from Sauri) into a water stress index. This water stress index (WRSI), which has been commonly used in other index insurance schemes, takes into account crop sensitivity to water deficits throughout the growing cycle. The advantage of using WRSI over simple monthly or seasonal rainfall totals is that WRSI incorporates the specific attributes of the staple maize variety grown in Sauri during the March-May long rains, as well as a range of other local soil and climate characteristics. The result is a more robust representation of how available rainfall has impacted local maize production, and thus farmers' livelihoods. To facilitate this process, numerous farmer surveys have been conducted about planting practices.

The relationship between WRSI and observed historical droughts is enhanced[2] by linear multiple regression with a satellite-derived vegetation index (NDVI) to form a 'climate impacts index'. The addition of NDVI limits basis risk by spatially averaging vegetation "greenness" during the most critical period in the maize growing season (flowering) over an approximately 200km x 200km area of similar agroecological classification around Sauri. Because this information is gathered from satellite, it also facilitates data monitoring and reduces the risk of tampering with ground-based weather stations. Although satellites that supply NDVI data change over time, the operational dataset we will be using is quality-controlled, robust, and monitored continuously for shifts in orbital

[2] A 22-year timeseries correlation coefficient between WRSI and observed historical maize production for the Sauri region is 0.41. After including NDVI information for the "climate impacts index", this correlation improves to 0.49. The addition of NDVI also substantially improves the payout timing, leading to an index that pays out in all of the three worst years without any unnecessary payments.

drift and angle of incidence to maintain data continuity over time. For this particular contract there would have to be a systematic shift of greater than +30% in NDVI weighting in order to change the ranking of the top three years of the climate impacts index. Additionally, the USDA RMA is piloting an index insurance scheme using NDVI during 2007, so its use in this application is not unprecedented.

Historical performance of the climate impacts index

Our climate impacts index is intended to pick out the worst drought years on record from the combined WRSI and NDVI datasets, with the assumption that those years also correspond with the most intense climate-related impacts on livelihoods in Sauri.

Ranked analysis of historical drought in Sauri, Kenya (1982-2003)				
Observed worst maize production years	Rainfall only	WRSI only	NDVI only	**"Climate impacts index" (WRSI and NDVI)**
1984	***2000***	***2000***	***1984***	***2000***
2000	1999	1997	***2000***	***1984***
1992	1997	**1992**	1983	**1992**
1983	**1992**	1983	1990	1997
1985	1995	***1984***	1994	1983
1991	1989	1982	1996	1993
1999	1993	1989	1999	1990
2002	1985	1993	1991	1986
1982	2002	1986	**1992**	1999
1993	1982	1998	1993	1991
2001	2001	2003	1986	1995
2003	1990	1990	1997	1996
1990	2003	1987	1995	1994
1995	1994	1995	2001	1989
1996	***1984***	2002	1998	1998
1997	1996	1999	1985	2003
1986	1983	1988	2002	2002
1987	1986	1991	1989	1982
1988	1987	1985	2003	1985
1989	1998	1996	1987	2001
1998	1991	1994	1982	1987
1994	1988	2001	1988	1988

Table 1: A ranked analysis of historical drought years in Sauri, Kenya. Payout years are in bold. Full payouts (extreme droughts) are in italics.

The inclusion of NDVI data into the climate impacts index reduces the possibility of false and missed payouts, and thereby increases the chances of overall project success. For instance, analysis of 1984 (historically one of the worst droughts in Western Kenya) by rainfall or WRSI only does not consider this year extreme. The reason is that in 1984 in Sauri there were a handful of large rainstorms, which interrupted long dry spells. The spatially-averaged estimate of NDVI helps to better capture these sporadic rainfall events and shows the effect of these rainfall patterns over a wider area than the rain gauge itself. By using both the local (WRSI) and regional (NDVI) data sources together, we are able to provide a more accurate account of historical drought in Sauri.

Although historical production data for Sauri itself is uncertain and subject to variation based on a number of factors (not all climate related), a number of independent sources such as collective village memory, FAO food aid records, and nearly a decade of recent district-level production data from the Kenya Ministry of Agriculture all point toward an agreement that 1984, 2000, and 1992 were the worst droughts in the last quarter century.

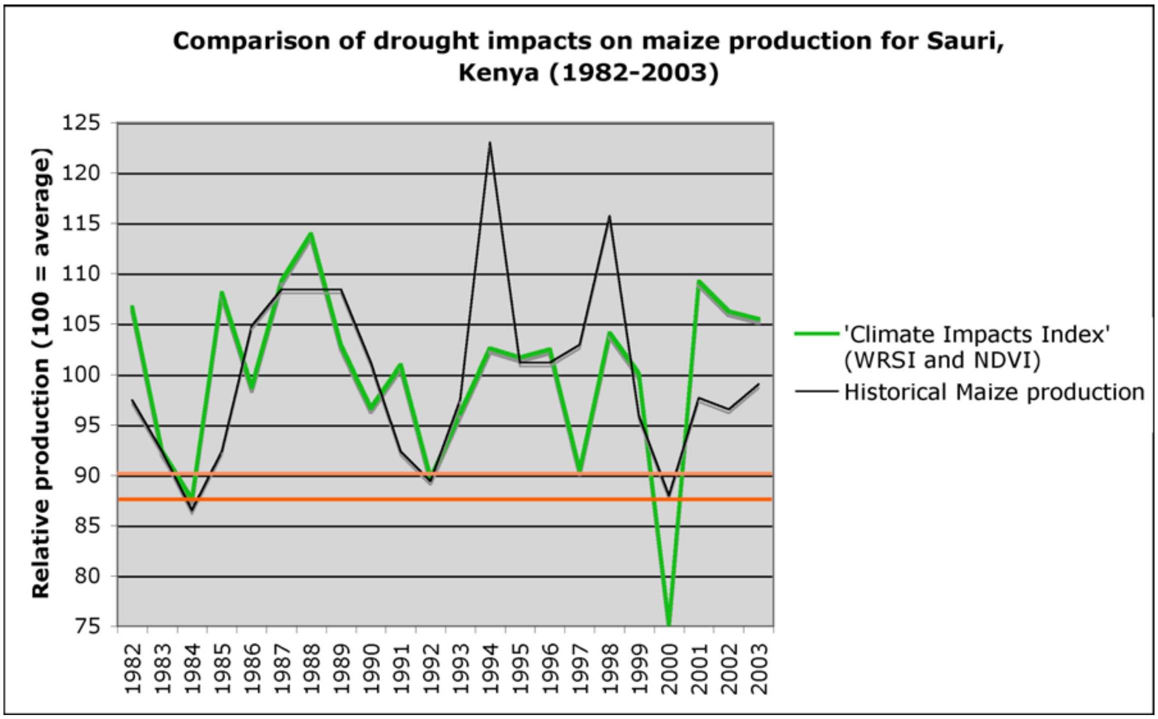

Figure 2: Timeseries analysis of estimated historical drought impacts (based on WRSI and NDVI) vs. observed maize production for Sauri, Kenya. Upper threshold is for 1 in 8 year events, lower threshold is for 1 in 20 year events.

Project interventions funded by payouts

Annually, data used to compose the season's climate impacts index will be compiled by July 1st, approximately 4-6 weeks prior to peak harvest season in Sauri. At that point, potential insurance payouts can begin to be processed. Ideally, payouts will be available to village-level project staff before drought impacts become severe. The main interventions will be ensuring the continuity of the school lunch program, guaranteeing farmers have necessary agricultural inputs for the next growing season, and providing emergency food aid, if appropriate.

Whenever payouts are to be issued, two scenarios are possible. For moderate drought events (events falling between the two payout thresholds) a pre-specified "alert mode" plan of action will be implemented, which includes supplementing the village school lunch program (where local farmers provide excess food to local schools) and facilitating the procurement of seeds and fertilizer for the next growing season. For extreme drought events (below the lowest payout threshold), a pre-specified "disaster mode" plan of action will be implemented, which includes full funding of the school lunch program for the entire school year, providing full replacement of lost seeds and fertilizer stocks for the next growing season, and emergency food aid for the most vulnerable populations of the village, where necessary.

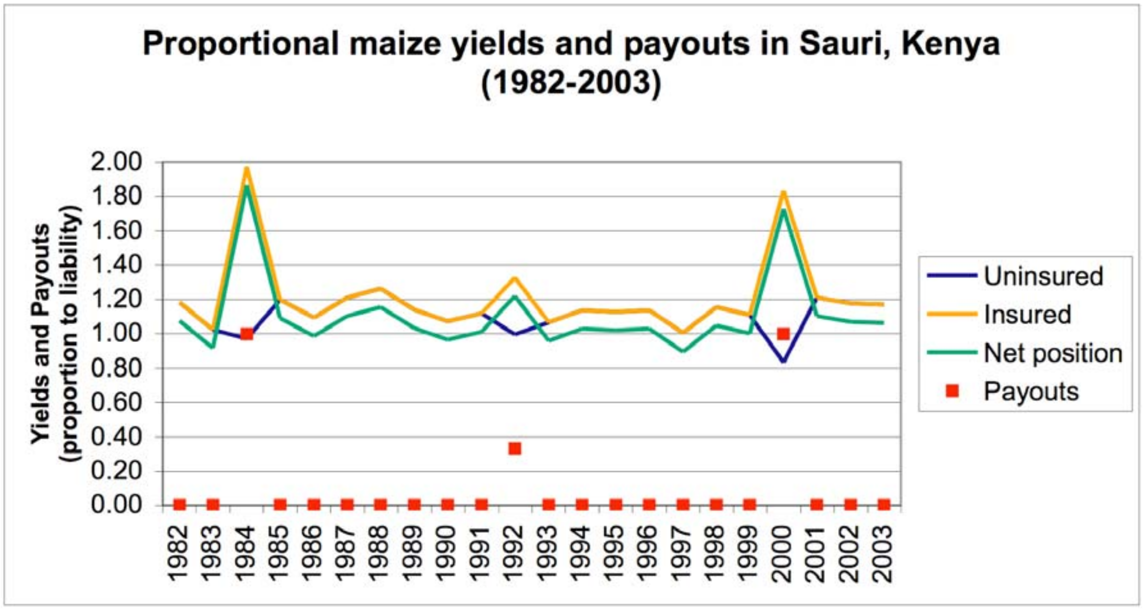

Figure 3: Historical yields and payouts, assuming full payouts in extreme drought years, and payouts in moderate drought years equal to one-third maximum payout.

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