Cooperation, institutional quality and management outcome in community based micro hydro schemes in Kenya

Mary Karumba
University of Cape Town

Sup: Prof. E. Muchapondwa

Background

- Sub-Saharan Africa has the lowest electrification rate at 32 per cent compared to world access rate of 83 per cent
- Inequality (urban rate=59%; rural rate=7%)
- Development challenges related to use of unclean fuels are therefore likely to be more in this region
- Economics of grid extension (low income; scattered households)
- sustainable development goals have led to promotion of other alternatives
- Decentralized renewable (_*) energy micro grids (community owned micro hydro grids)
- registering low success rates (Palit and Chaurey, 2011 among others)-where they are needed most
- Ownerhsip and operation structure of community owned micro grids has specific challenges that make them difficult to run

Background...

- Wolsink (2012) among others state that community micro grids have properties of a man-made CPRs
- Hardin's tragedy - Hardin (2009) vs self governance conditions-Wade(1987); Ostrom(1999)
- emerging role of individual heterogeneity (characteristics) on participation -Lise(2000); Dolisca(2006); Coulibay-Lingani(2011) among others
- Greacen (2004); Maier (2007); Gollwitzer (2014&2015) - characterization of the CPR in CBMHs
- Gap 1: prospects for individual cooperation within CPRs is widely assumed in both literature and practice- yet they are the basic units
- Gap 2: no link between suggested principles of governance and the observed outcome in CBMHSs
- We expolit field data from collpased and successfull CBMHSs in Kenya to establish such a link.

Objectives of the study

1. Identify individual characteristics that influence individual's cooperation
2. Establish the role of suggested conditions for managing commons relate to the observed outcome (particular interest in the role of local institutional quality)

Context

- Kenya (national rate 20%; urban rate 60% and rural 7%)-rural communities need affordable alternatives (even with grid electricity)
- Available setting for a potential hydro micro grid project (established resource; familiarity of respondents with technology; interest)
- Energy Policy-liberalized production and distribution of electricity
- **Communities** and private individuals allowed to exploit <1MW
- with communities so far showing greater interest

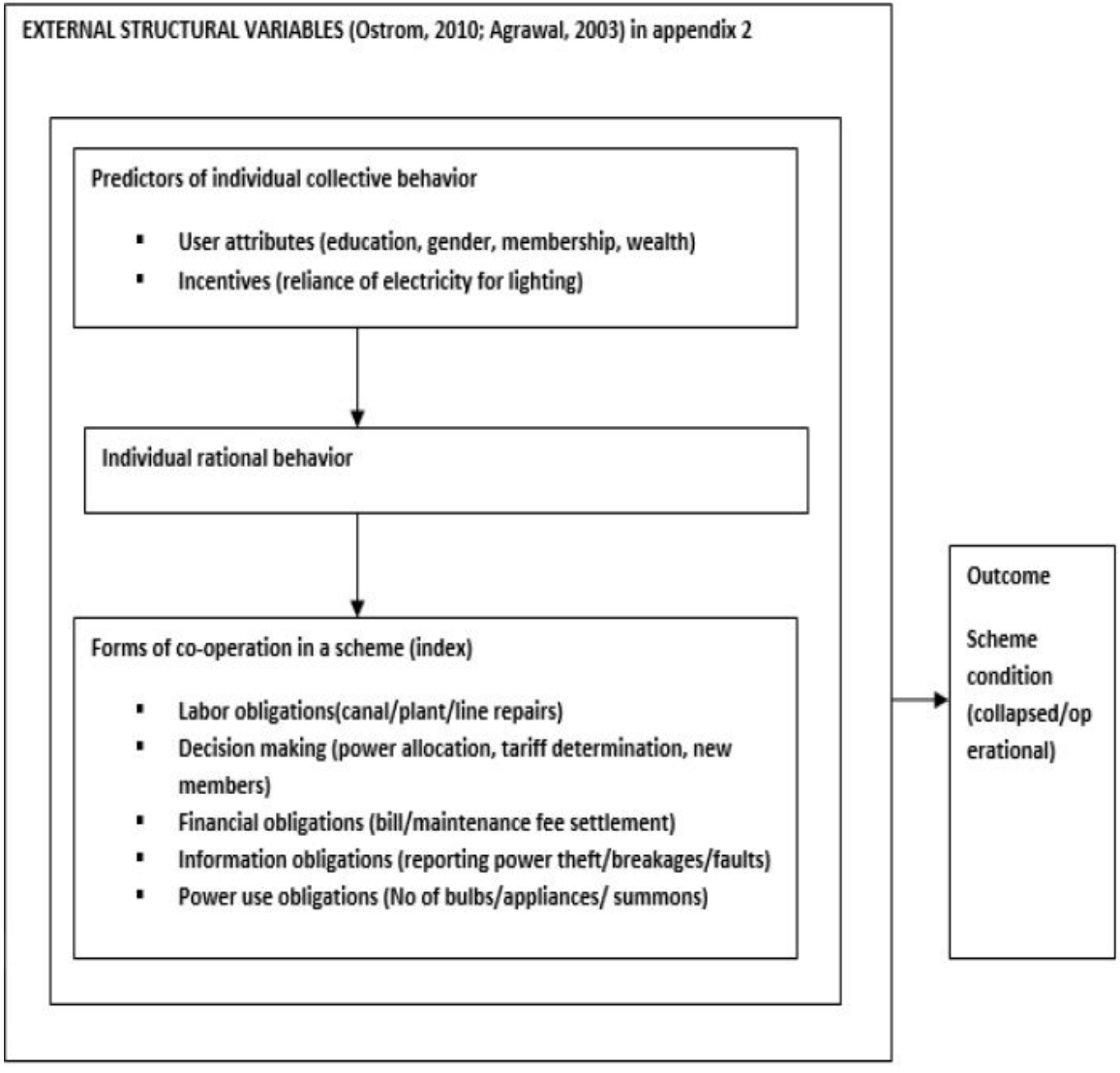
Context

- Resource (labour and capital) pooling for construction and maintenance
- Joint ownership of the micro grid and generated electricity that is utilized at the household point
- limited capacity is common due to capacity/financing constraints
- rules stipulating the utilization of electricity (to prevent overload) and other conduct in the scheme
- 50 per cent of such start ups have failed due to among others- failure of self-governance
- Potential policy gap -Scheme formation & survival largely left to clueless community with donors/GoK handling financing

Contribution

1. literature: we extend the application of CPR management principles to man-made energy commons
2. policy: potential interventions likely to increase the cooperation of members and positive outcome within CBMHS

Methodology-Conceptual Framework



Adapted from Ostrom (2010)

Empirical strategy

- suggested individual characteristics influence the level of cooperation with local scheme rules and regulations
- we use a simple LS estimation to identify what characteristics are supported by our field data
- In the second stage, we look for the **conditions (predictors)** of management outcome observed in schemes
- The relevant conditions for micro hydro CPR are suggested in exploratory studies [Greacen (2004); Maier (2007); Gollwitzer (2014&2015)]
- our interest - **quality of locally devised institutions & individual coperation** on the outcome, while accounting for other relevant conditions
- Institutions refer to recognized rules to direct smooth conduct of business in a scheme that are common in micro hydro schemes
- note: cooperation and local institutions are depicted by several indicators constructed from concepts depicitng them in the data

Empirical strategy-Objective 1

- LS estimation (with necessary tests)
- $Indexpart_i = \beta_0 + \beta_1 educ_i + \beta_2 enviclub_i + \beta_3 memtenure_i + \beta_4 trust_i + \beta_5 enerexperatio_i + \beta_6 incentive_i + \beta_8 wattsphh_i + \beta_9 gender_i + \beta_{10} landacr + \beta_{11} schemecode_i + \varepsilon_i$
- A coopertive member is defined as one who fulfills several requirements as follows:
- These can be combined into one variables (PCA) giving an indicator of individual cooperation level

Table: variables comprising of participation in the group

Notation	**description**	**Type**
billset	**meets financial contribution**	**scale**
freelab	**meets free labor contribution**	**scale**
infrep	**providing information**	**scale**
Patpatro	**Patroling to guard plant**	**scale**
decpat	**participating in decisionmaking**	**scale**
meetatted	**attending to scheme meetings**	**scale**

Empirical strategy-Objective 2

- governance conditions and observed (binary) outcome in a micro hydro scheme
- Local institutional arrangements comprises of various concepts as follows (PCA)

Table: Variables for Institutions

Variable	**Description**	**Type**
lowcost	**low cost justice system**	**binary**
apprules	**Appropriation match generation**	**binary**
leaderacou	**leaders are accountable**	**binary**
gradpenal	**graduated sanctions**	**binary**
rules_adjusted	**adjustment of rules**	**binary**
rulesenforce	**rules are easy to enforce**	**binary**
rules_understand	**rules are easy to understand**	**binary**
rules_making	**are the rules locally devised**	**binary**

Empirical strategy-Objective 2

- binary outcome model with the probability of observing a scheme management outcome as follows:
- $p = pr[s = 1|C] = F(C'\alpha)$ with s=1 if scheme is functional and 0 otherwise
- where C are the conditions (explanatory variables) and α are the coefficients
- assume that S_{ni} takes on the value 1with a prob π_{ni} or 0 with prob- then S follows a Bernoulli distribution
- $Pr(S_{ni} = s_{ni}) = \pi_{ni}^{s_{ni}}(1 - \pi_{ni})^{(1-s_{ni})}$ with $\pi_{ni} = C'_{ni}\alpha$, where αrepresents regression coefficients. Empirically,
- $\pi_{ni} = \alpha_0 + \alpha_1 lnsindex_{ni} + \alpha_2 Indexpart_{ni} + \alpha_3 inequality_{ni} + \alpha_4 externalfund_{ni} + \alpha_5 groupsize_{ni} + \alpha_6 boundary_{ni} + \alpha_7 resourcesize_{ni} + \alpha_8 monitor_{ni} + \alpha_9 interfere_{ni} + \alpha_{10} socialcapital_{ni} + \eta_{ni}$
- odds expression→logit/logodds transformation→ assume that logit of underlying probability is a linear function of C
- $\pi_{ni} = \frac{exp\{C'_{ni}\alpha\}}{1+exp\{C'_{ni}\alpha\}}$ (our interest is the sign of α)

Sampling and Data collection (Kenya (Nov-Dec, 2015)

- List of functional and collapsed schemes was obtained from a scoping study by Global Village Enterprise Partnership(GVEP) International
- Updated with personal visits to the projects by the researcher (approximated 746 members spread in 4 functional and 5 collapsed ones)
- targeting a third of the members in each group, a proportional allocation of the sample was done based on the total membership
- This was adopted because the membership became difficult to establish for some schemes
- The expected and realized samples are shown in tabel
- systematic pick of names from existing registers or using physical location and skipping nth member
- Both individual level and group level information was collected
- Group level information was through focus groups through randomly selected members

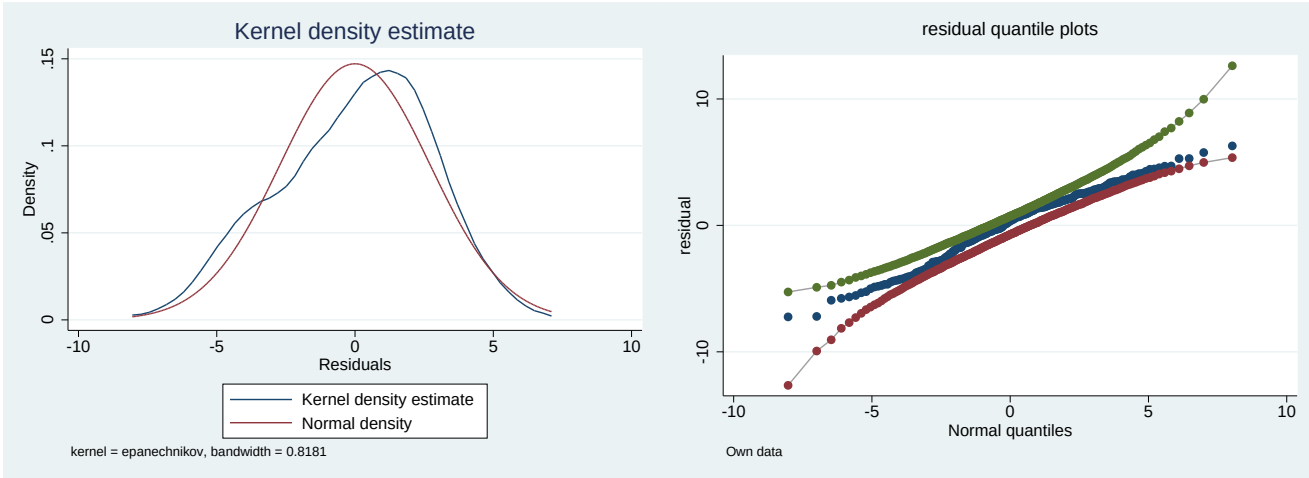
Results:Some Sample Characteristics (mean)

scheme(status)	*0(0)*	*1(0)*	*2(1)*	*3(1)*	*4(0)*	*5(1)*
age	*55.9285*	*54.2500*	*53.5882*	*62.7143*	*49.65217*	*62.2973*
yrseducation	*8.7857*	*10.8750*	*9.7059*	*7.5714*	*8.5217*	*6.8378*
yrs in village	*43.8571*	*42.75*	*41.7059*	*58.1429*	*35.6087*	*51.1351*
landacr	*1.4643*	*1.1746*	*1.2959*	*1.5928*	*0.8349*	*2.1301*
income (Ksh)	*23598.93*	*16683.82*	*17209.82*	*10152.14*	*22707.09*	*17976.82*
imput_inco (Ksh)	*10371.43*	*13962.5*	*15074.53*	*4428.571*	*14621.74*	*15190.54*
Eexpratio	*0.0496*	*0.0792*	*0.1087*	*0.1087*	*0.0965*	*0.0825*
Group level information						
gender ratio	*0.20*	*0.44*	*0.50*	*0.00*	*0.22*	*0.14*
group age(yrs)	*10*	*12*	*5*	*10*	*0.7*	*7*
reso˜ size(kw)	*3*	*1.1*	*11*	*1*	*10*	*11*
group size	*76*	*150*	*70*	*150*	*25*	*60*
ins_index	*0.84*	*0.13*	*1*	*0*	*1*	*1*
part_ level	*0.81*	*0.65*	*0.80*	*0.82*	*0.51*	*0.77*
n=236 mean insti_index=0.67; mean participation_index=0.68 ; 1 USD= Ksh. 100						

Results:How do individual characteristics relate to observed level of cooperation

Variable	*coefficient(s.e.)*	*coefficients(Bootstrap S.E)*
Education level (yrs)	*0.1128(0.0437)****	*0.1128(0.0425)****
Membership to envir. club	*0.6215(0.4307)*	*0.6215(0.4616)*
yrs of membership in scheme	*0.0969(0.0852)*	*0.0969(0.0788)*
Trust for peers	*2.6742(0.6275)****	*2.6742(0.6617)****
Energy share %HH budget	*5.4181(2.0304)****	*5.4181(2.0698)****
Incentive(grid connection)	*0.6830(0.6075)*	*0.6830(0.5935)*
watts/hh	*0.0191(0.0059)****	*0.0191(0.0062)****
Gender(male)	*-0.4917(0.4145)*	*-0.4917(0.3890)*
Asset ownership (Land acres)	*-0.0189(0.0813)*	*-0.0189(0.0840)*
Scheme3	*2.7126(1.0620)****	*2.7126(1.1630)***
Scheme4	*-2.2477(0.7994)****	*-2.2477(0.8450)****
Scheme6	*3.2028(1.1103)****	*3.2028(1.1211)****
k	*2.0101(1.000)****	*2.0101(0.9399)***
n	*236*	*236*

Results:Diagnostics #1



Results: Which suggested conditions matter for CBMHS outcomes?

Table: Predictors of successful management of a scheme

Variable	*logit-coeffic(s.e.)*	*m.e. (at means)*
Institutional_ind	*1.6904(0.8495)***	*0.4226(0.2124)***
Participation ind	*3.0816(0.5761)****	*0.7704(0.1440)****
Asset inequality	*45.7784(12.2655)****	*11.4446(3.0653)****
External_funding	*0.4085(1.4898)*	*0.1014(0.3638)*
group size	*0.0496(0.0128)****	*0.0124(0.0032)****
Boundary of users	*7.3115(2.0511)****	*0.9478(0.0507)****
Resource_size	*1.1857(0.3434)****	*0.2964(0.0858)****
k	*-64.3262(12.1189)****	
log-likelihood	*-25.9310*	
Pseudo R^2	*0.8413*	

**, ***significant at 5% and 1% respectively

Results #1

- argument - individual characteristics indeed affect peoples cooperation scores in CBMHS
- Less educated members have lower scores, due to difficulties conceptualizing the benefits
- Similar findings for participants in forest commons (Jumbe, et al., 2007 &Dolisca et al., 2006)
- those who trust their peers have higher scores - experimental studies support this the same in grazing commons Hayo et al. (2012)
- Trust increases confidence making individuals to commit more to scheme activities/laws- trust building activites in groups?
- Members in schemes with higher electricity allowance per member (benefits) have higher cooperation scores- invest in larger plants
- see Coulibay et al., 2011 & Muchara et al., 2014 for similar observations in forest and irrigation commons respectively

results #2

- A higher score (quality of local institutional arrangements increases the probability of a successful scheme (m.e=0.42)
- Community development workers should aid schemes to improve the nature of institutional arrangements
- identified what constituties these local institutional arrangements for CBMHS through the concepts comprising this index
- even greater role of member cooperation (m.e. =0.77)
- driving forces are now partially known from the concepts comprising this index
- Educating participants on the linkage between their individual actions and subsequent outcome should be consistently emphasized

Results #2 ...

- this should form part of the mobilization/promotion plans for such schemes
- Further, there is less worry over high inequality among scheme members, holding all other factors constant (schemes appeal to even asset rich households)
- Larger groups sizes should be encouraged together with exploitation of max. capacity from the hydro resource since they are associated with higher chances of survival of schemes
- During early project studies, its crucial to clearly define the community members who can or cannot benefit from the CBMHS electricity.
- This reduces conflicts in the future when additional members like relatives want to join in-which may subsequently overload the system.

Conclusion ...

- Concern was the individual characteristics that associated with their cooperation in CBMHSs commitments and
- the relationship between suggested conditions for managing commons and observed outcome in schemes.
- borrowed a conceptual framework from the study of commons-accepting that CBMHSs have features of a CPR
- Our data supports most proposals from literature and findings in studies of other commons (e.g. education, trust and higher derived benefits create an impetus for higher cooperation)
- important to support development of good quality local institutional arrangements, promoting more larger plants and bigger groups to increase chances of a positive management outcome
- Study provides some insights on potential actions that can improve the survival of community owned RE- replications from other countries are suggested.