Agent Based Models (ABMs)

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Workshop on Climate Migration Modeling

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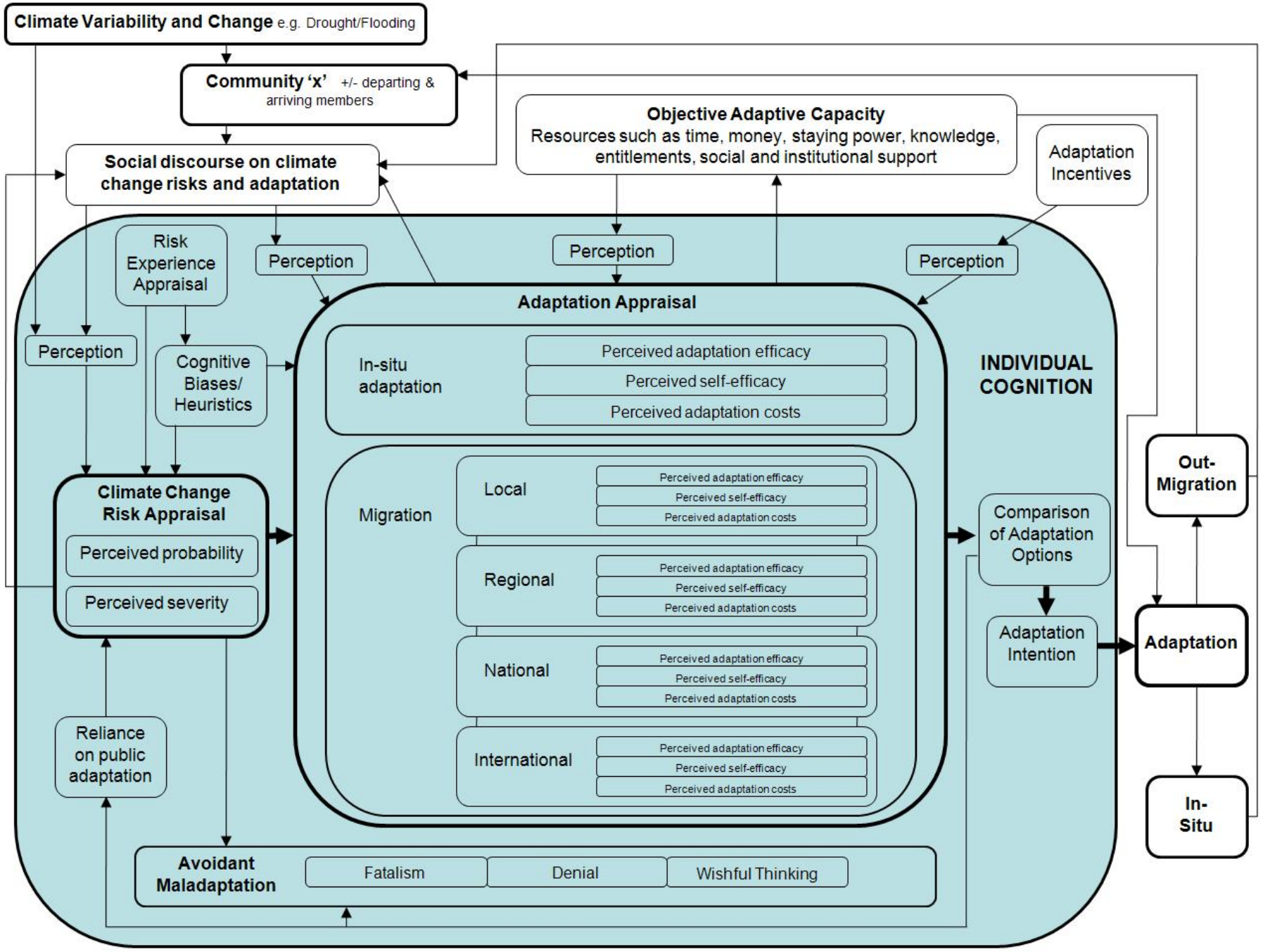
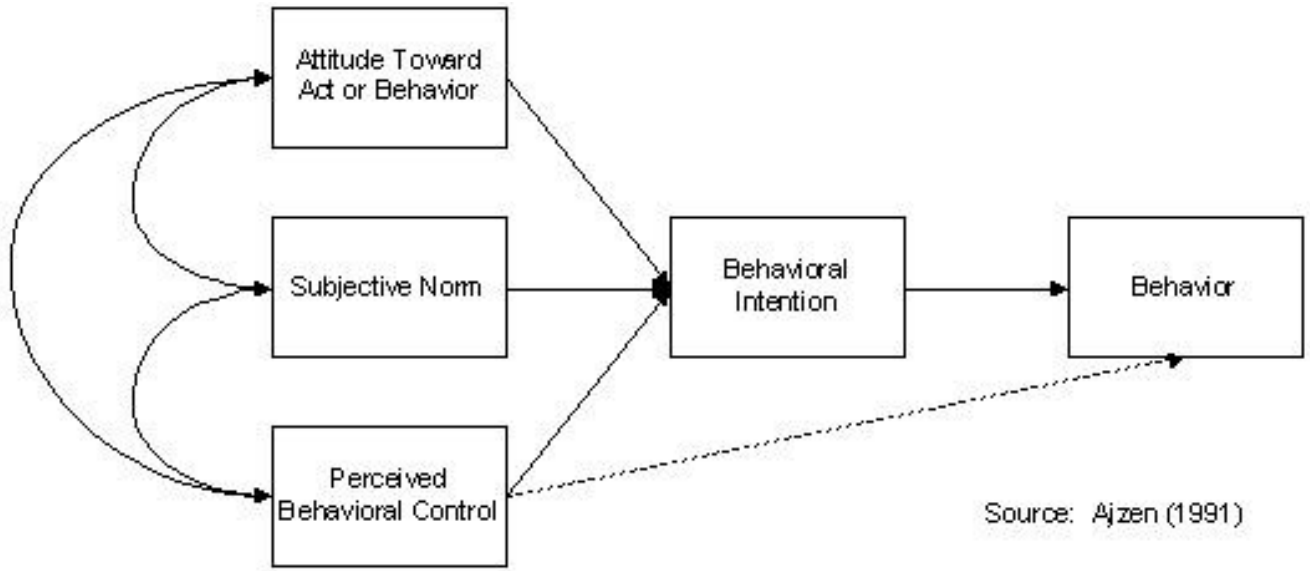
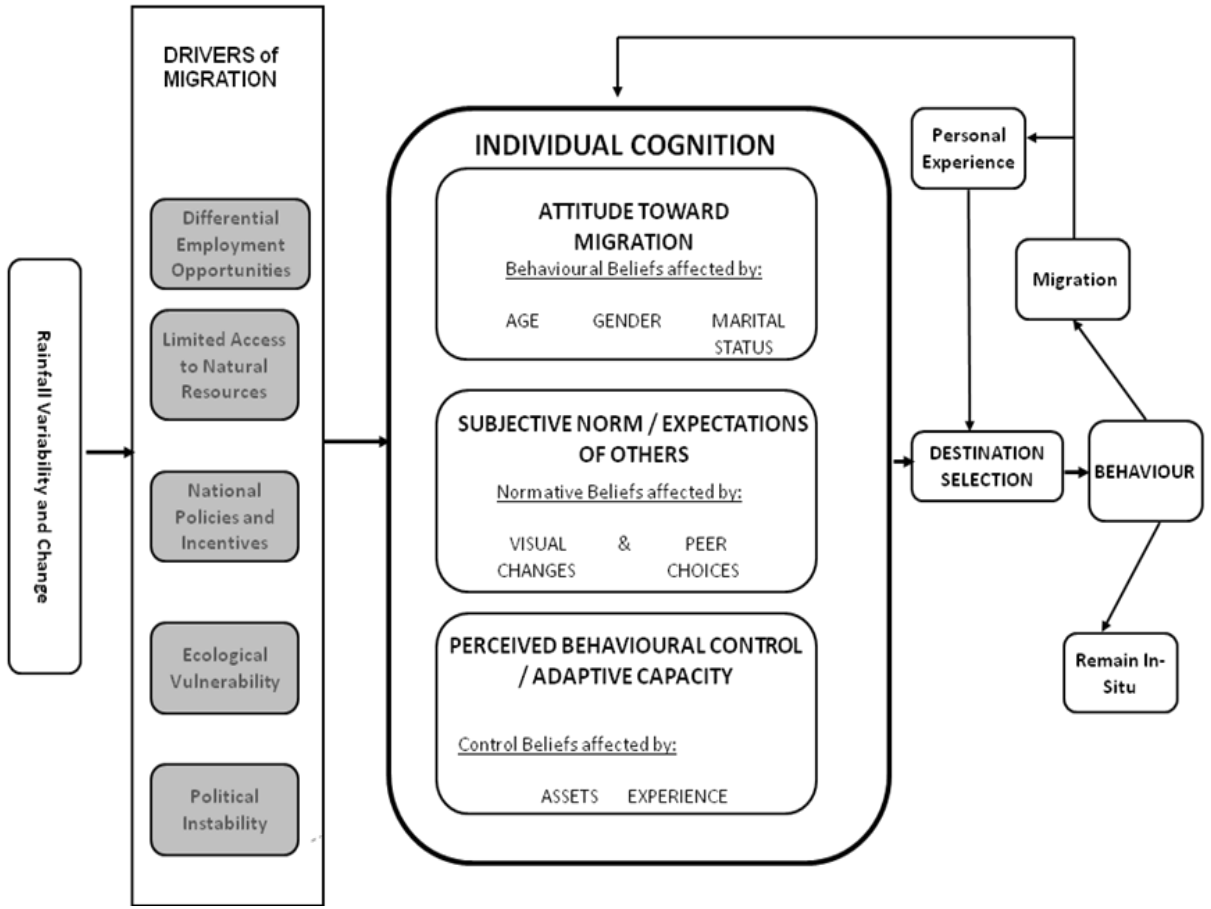
Agent Based Modelling

- Involves treating households or individuals as agents.
- Assumes agents interact with each other to produce non-linear outcomes
- Space is crucial to these interactions and the agent's positions within that space are not fixed.
- The population of agents is heterogeneous.
- The agents exhibit complex behaviour such as learning and adaptation



Smith et al 2009, Modified from Grothmann and Patt (2005)

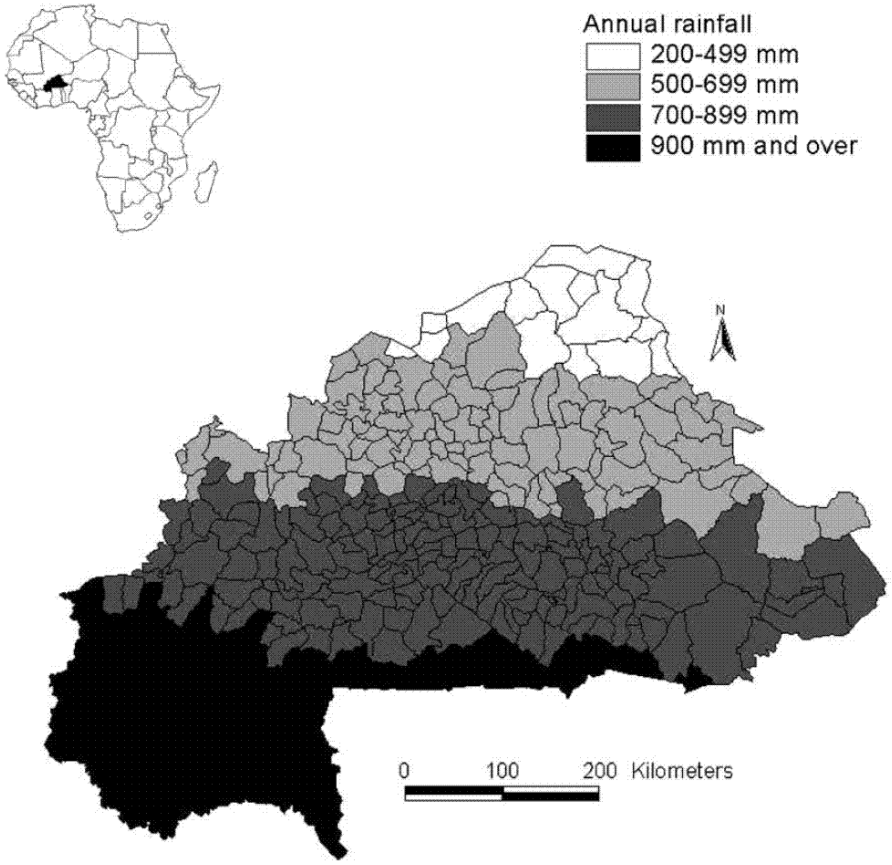

Attitude Toward Act or Behavior
Subjective Norm
Perceived Behavioral Control
Behavioral Intention
Behavior
Source: Ajzen (1991)

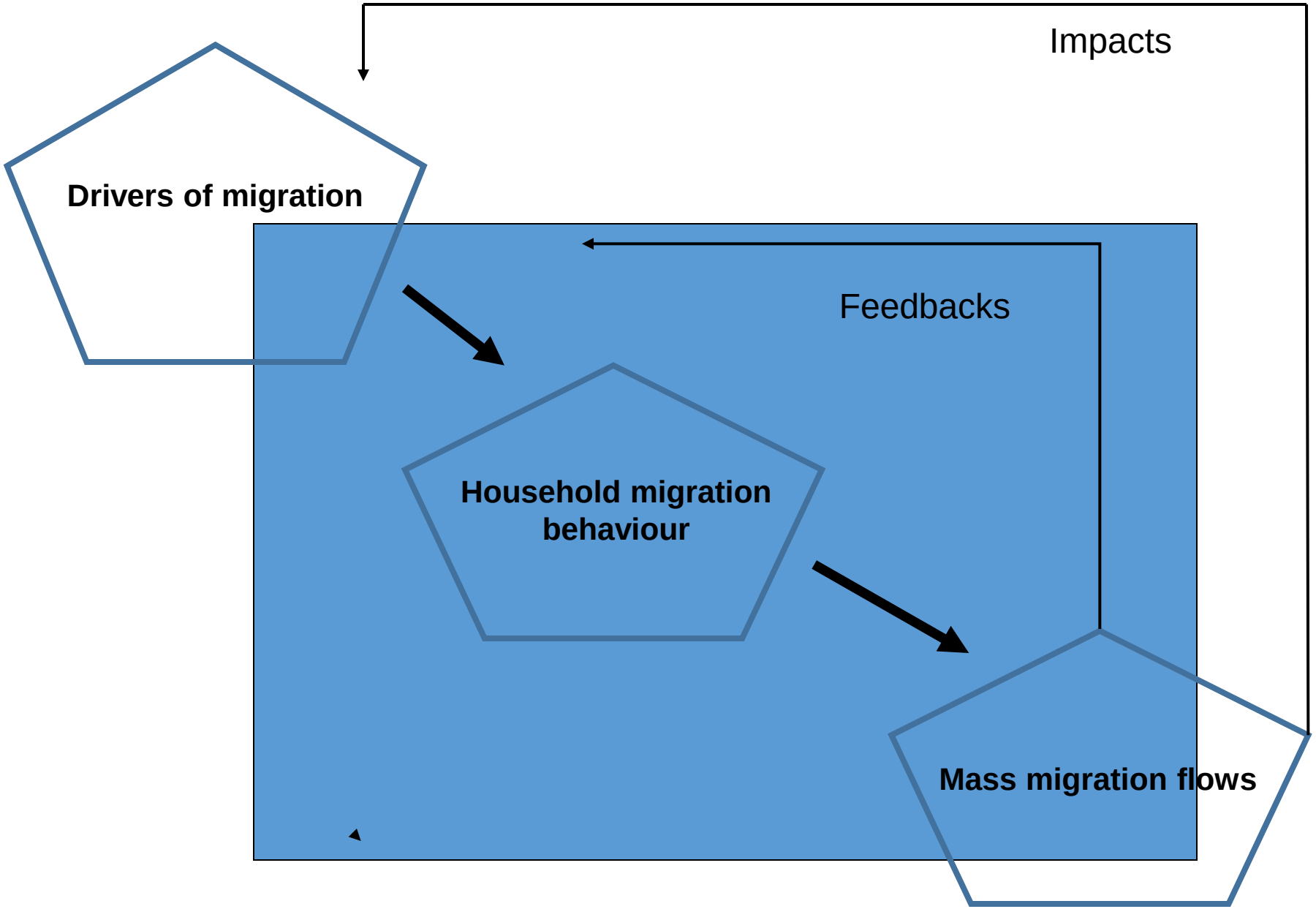


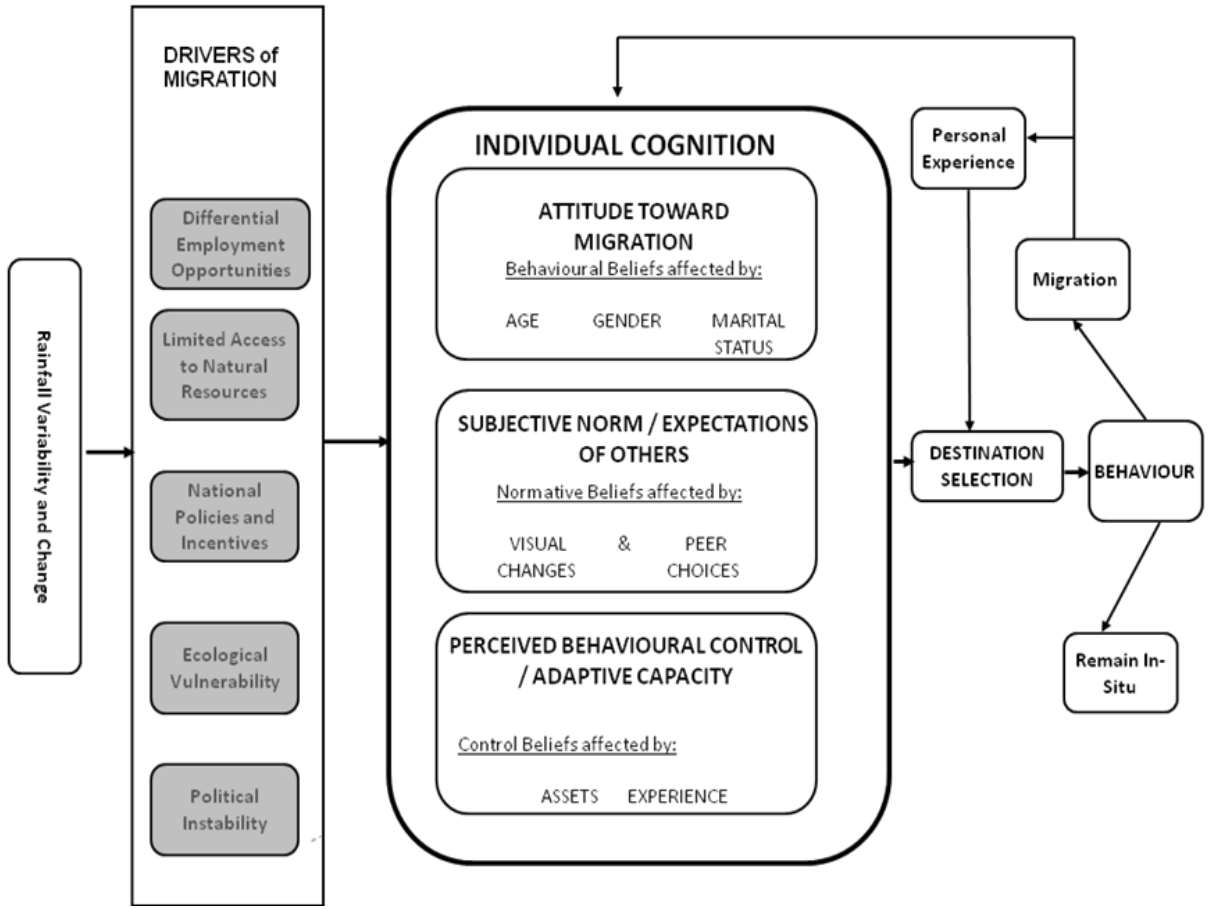
Kniveton et al 2012. Emerging migration flows in a changing climate in dryland Africa. Nature Climate Change, 10.1038/NCLIMATE1447

Migration and climate in Burkina Faso

- Population of 15 million.
- North-South rainfall gradient.
- Long characterised by mobility, historically to coastal plantation economies of Côte d'Ivoire and Ghana.
- Migration is mostly seasonal with family members returning home to farm their own land for the wet season (October - April).
- Internal migration is very common, mostly directed towards the wetter southwest of newly found goldmines.




Impacts
Drivers of migration
Feedbacks
Household migration behaviour
Mass migration flows



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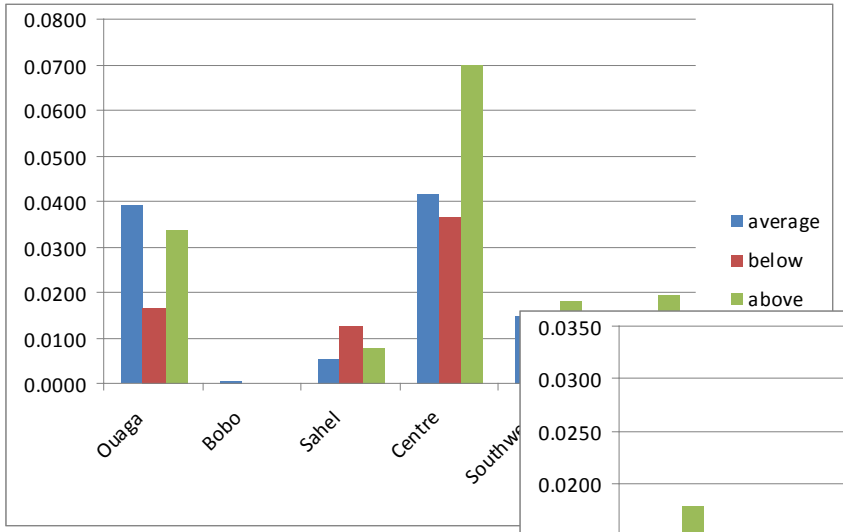
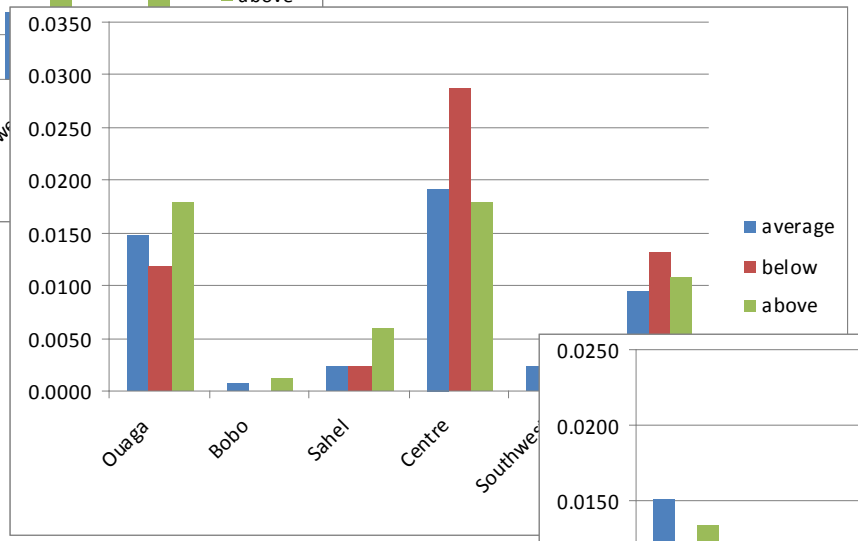
Probabilities of migration from the Sahel region for different rainfall conditions

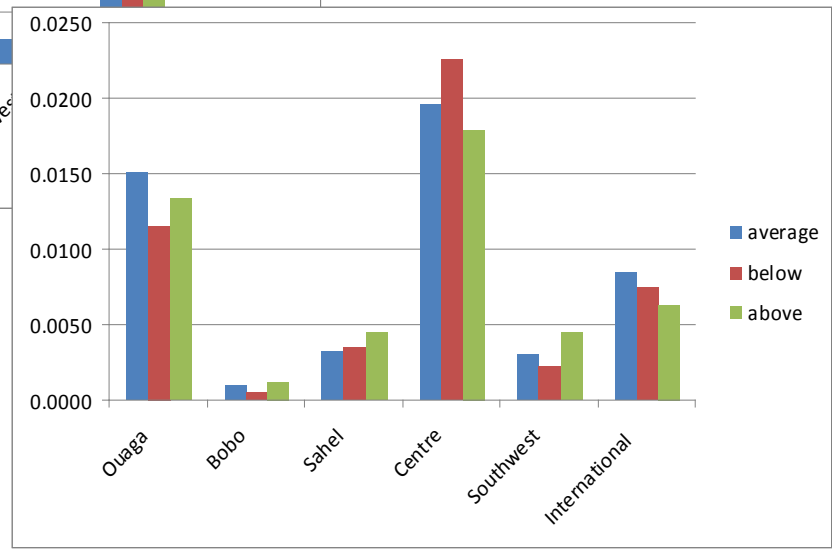
Age: 15-20 years

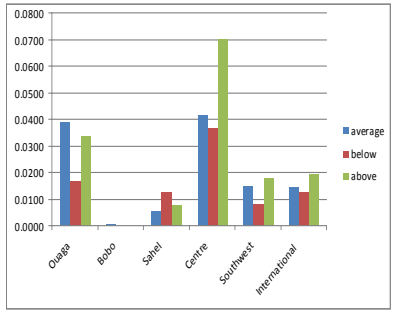


Gender: Male

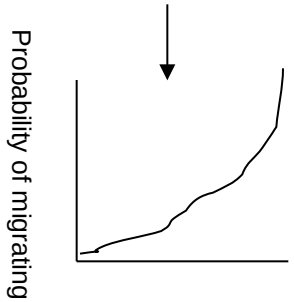


Marital Status: Married



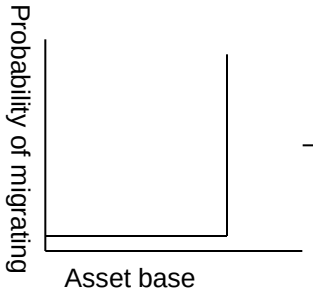


General probability of type of individual to migrate e.g. 15-20 yr old, single male.

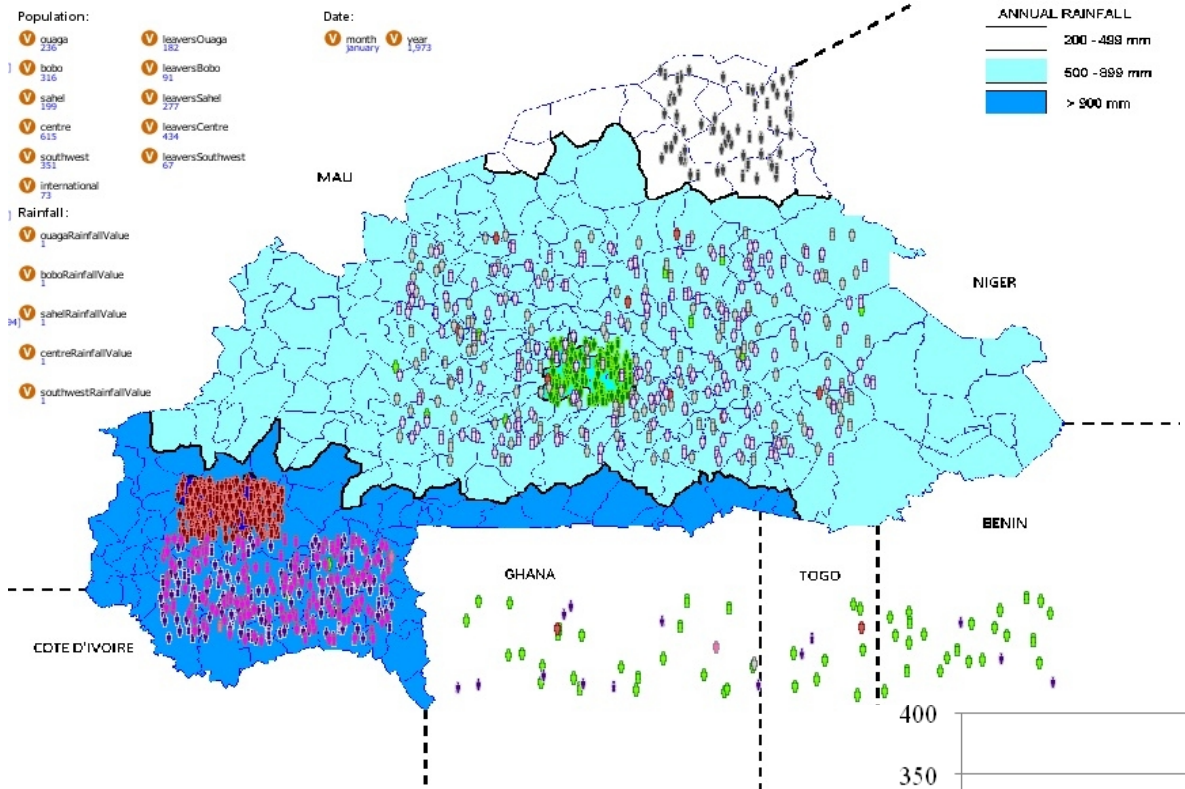


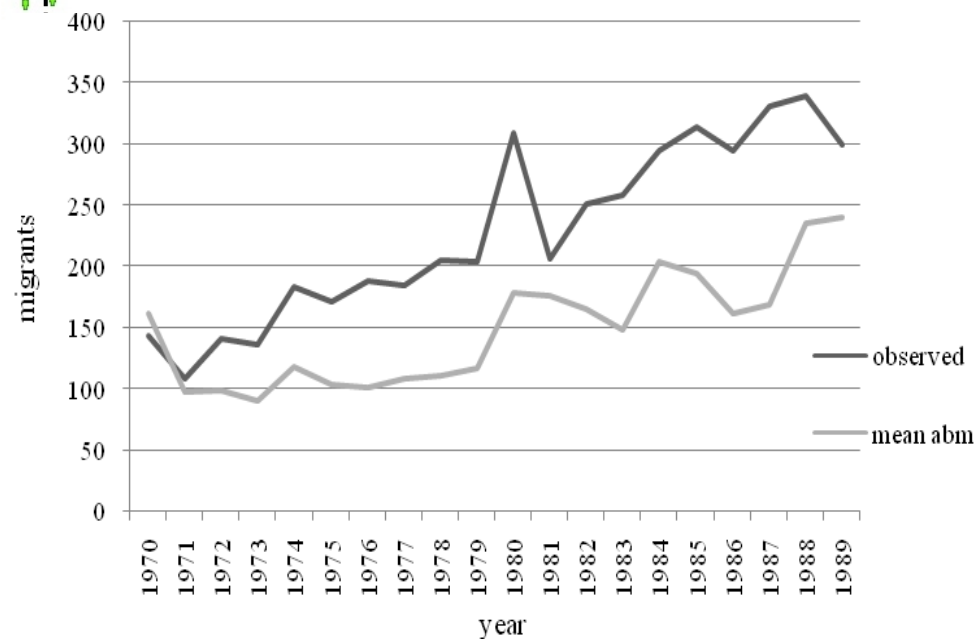
Aggregate migration of community

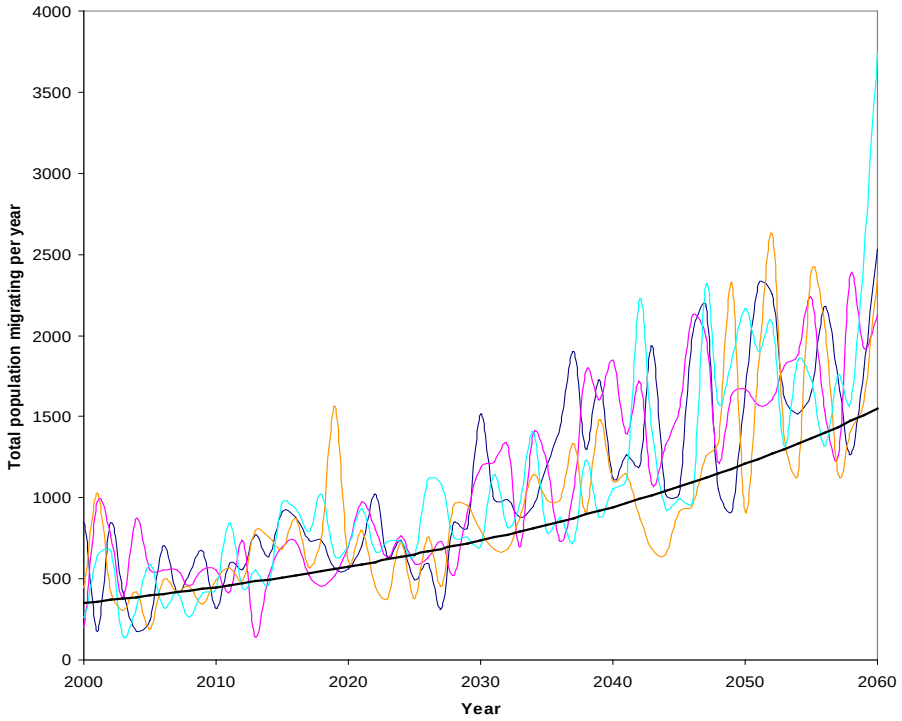
Probability of individual to migrate with particular social network

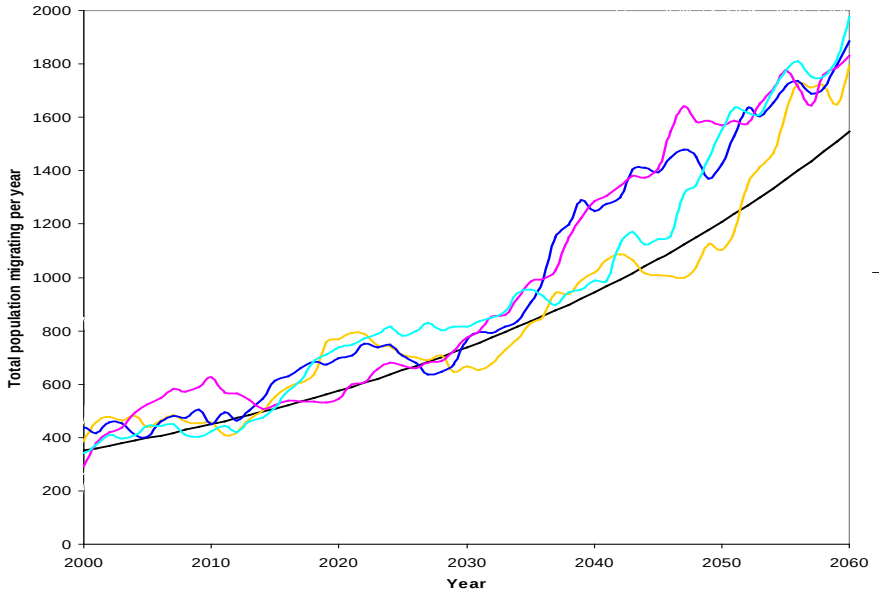


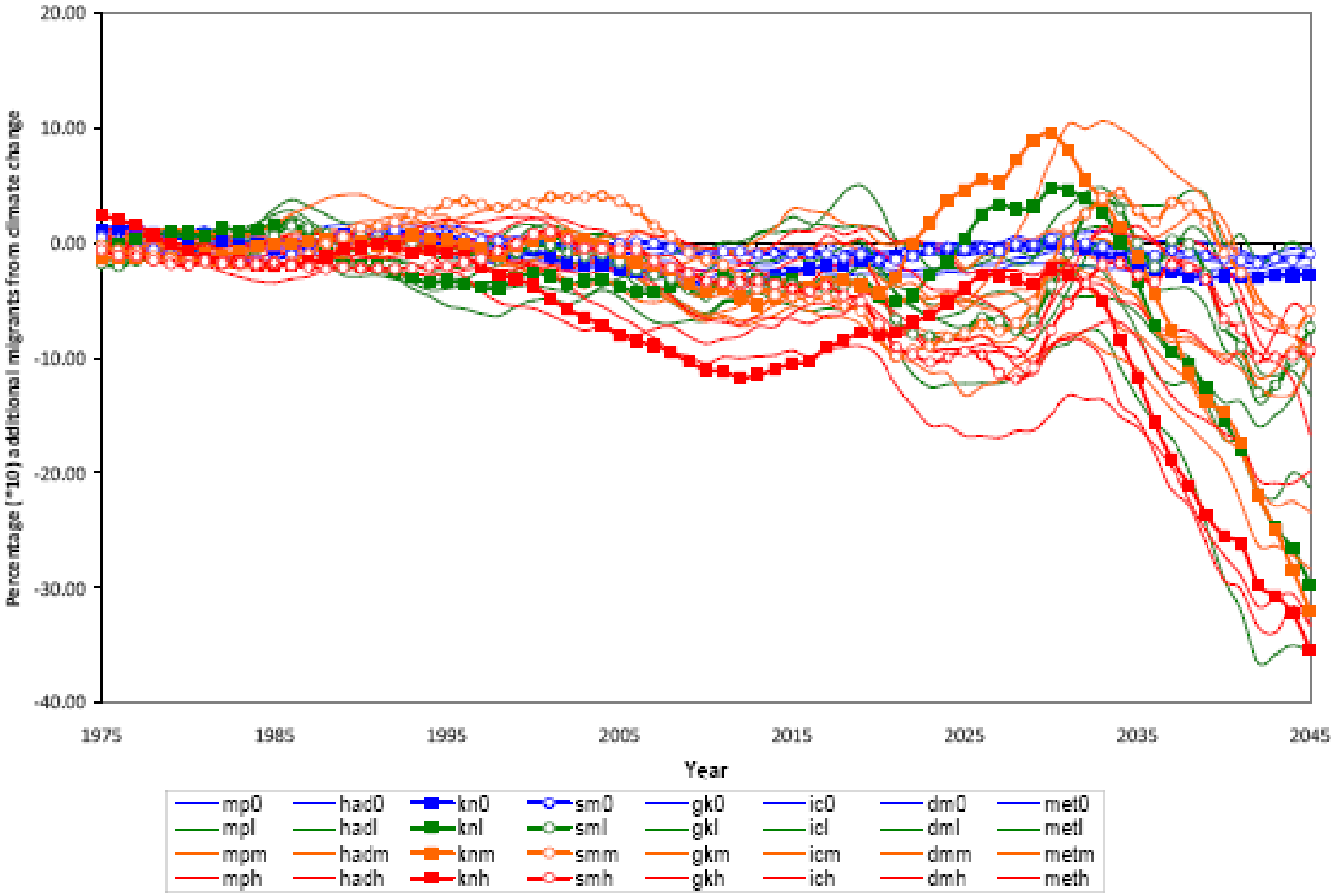
Probability of individual to migrate with particular social network & asset base


Population:
ouaga 236
bobo 316
sahel 199
centre 615
southwest 351
international 73
leaversOuaga 182
leaversBobo 91
leaversSahel 277
leaversCentre 434
leaversSouthwest 67
Date:
month january
year 1,973
Rainfall:
ouagaRainfallValue 1
boboRainfallValue 1
sahelRainfallValue 1
centreRainfallValue 1
southwestRainfallValue 1
ANNUAL RAINFALL
200 - 499 mm
500 - 899 mm
> 900 mm
MALI
NIGER
BENIN
TOGO
GHANA
COTE D'IVOIRE


migrants
400
350
300
250
200
150
100
50
0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
year
observed
mean abm


Total population migrating per year
Year
IPSL
ECHAM5
CCSM3
CGCM3
POP. GROWTH


Total population migrating per year
Year
POP. GROWTH
10 per. Mov. Avg. (CCSM3)
10 per. Mov. Avg. (IPSL)
10 per. Mov. Avg. (ECHAM5)
10 per. Mov. Avg. (CGCM3)


20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
Percentage (*10) additional migrants from climate change
1975
1985
1995
2005
2015
2025
2035
2045
Year
mp0
had0
kn0
sm0
gk0
ic0
dm0
met0
mpl
hadl
knl
sml
gkl
icl
dml
metl
mpm
hadm
knm
smm
gkm
icm
dmm
metm
mph
hadh
knh
smh
gkh
ich
dmh
meth

Conclusion

- An examination of the wider literature on decision-making outside of that concerning migration however highlights the importance of both conscious and non-conscious processing as well as the role of the social identity, the stage of change, social discourse, risk assessments, past experiences, emotions as well perception of behavioural and self-efficacy and subjective norms (for example see Grothmann and Patt 2005, Kuruppu and Liverman 2011, Beratan 2007, Damasio, 1996).
- Consideration of these variables opens up the study of climate-migration beyond the goal of producing projections of migration futures to question the nature of changing behaviour in the context of environmental and climatic change
- ABMs provide a means to explore emergent migration behaviour, test theories of decision making and derive heuristics around migration futures under certain assumptions

Ways forward?

- Do we really want to produce projections?
- Should we instead be testing theories about how people react to climate stresses and shocks and policies to manage these?
- Work of Cai et al 2016 & Cattaneo and Peri 2016 and project forward – i.e. using analog of annual temperature variability to understand mean changes
- ABMs based on country, livelihood climate stressor specific behavioural rules i.e. what would go do if…
- Combine above to explore how economic relationship is a function of previous migration and opening on new routes given heuristic of proximity (Cattaneo and Peri)