Spatio-Temporal Analysis of Land Use Land Cover Change in East Pokot, Kenya.

Amit Kumar Basukala[1,5], Michael Bollig[2], Clemens Greiner[3], Hauke-Peter Vehrs[2], Frank Thonfeld[4,5]

[1]University of Bonn, Center for Development Research (ZEF), Germany, [2]University of Cologne, Department of Cultural and Social Anthropology, Germany, [3]University of Cologne, Global South Study Centre, Germany, [4]University of Bonn, Department of Geography, Germany, [5]Center for Remote Sensing of Land Surfaces (ZFL), University of Bonn

Background & Goal

- Kenyan Rift Valley and East Pokot pastoralists are nowadays shifting from specialized (semi-) nomadic livelihoods towards agro-pastoral economies, which includes small-stock herding and crop farming mainly Maize as alternative, resulting in profound transition in Land use and Land cover change(LULC) (Greiner et al., 2013).
- Due to Transition of LULC the fragmentation of Savannah Landscapes is swiftly increasing through small-scale farming which result conflicts from competition for arable land in some areas
- Situation further worsen by steep demographic growth rates, dwindling resource bases, the erosion of traditional power structures, socio-cultural change, and livelihood diversification (Greiner et. al 2016).
- Maize cultivation started in 16th century by Portuguese traders, gained importance in colonial period and was established as the dominant food crop in most parts of Kenya by the 1930s.
- Further investment were done to meet food demand in early 1980s by large-scale development projects (Hassan and Karanja, 1997) which establish sedentary rain fed Maize farming as a central component in people's livelihoods.
- In recent years maize is the key food crop in Kenya and grown on an area of about 2 million hectares (FAO, 2013)
- Study conducted to understand the spatio-temporal dynamic change of pastoral land uses in the area with popularity in maize cultivation.

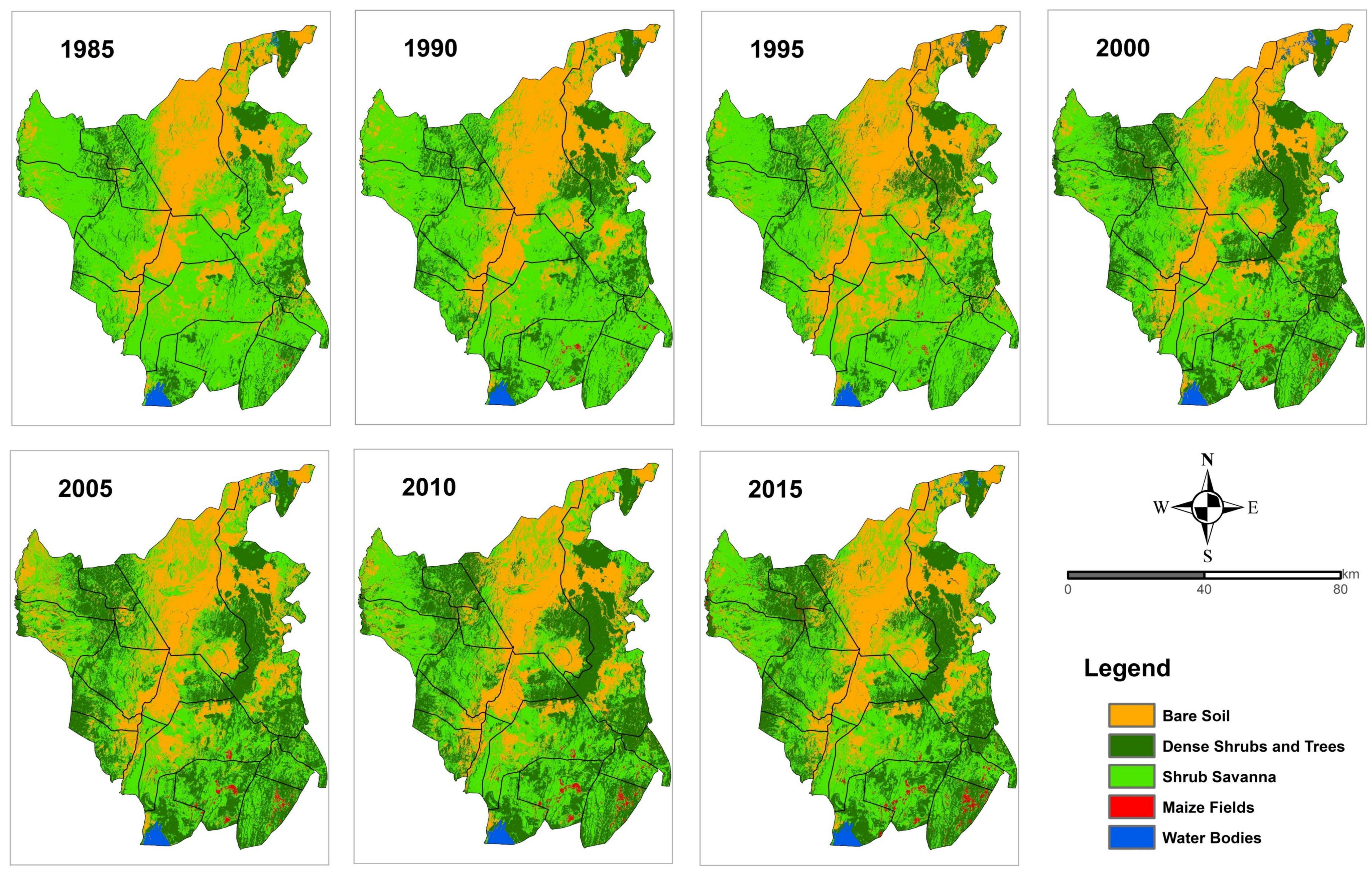

Fig. 1: LULC classification of the East Pokot and Surrounding Rift Valley of 1985, 1990, 1995, 2000, 2005, 2010 and 2015

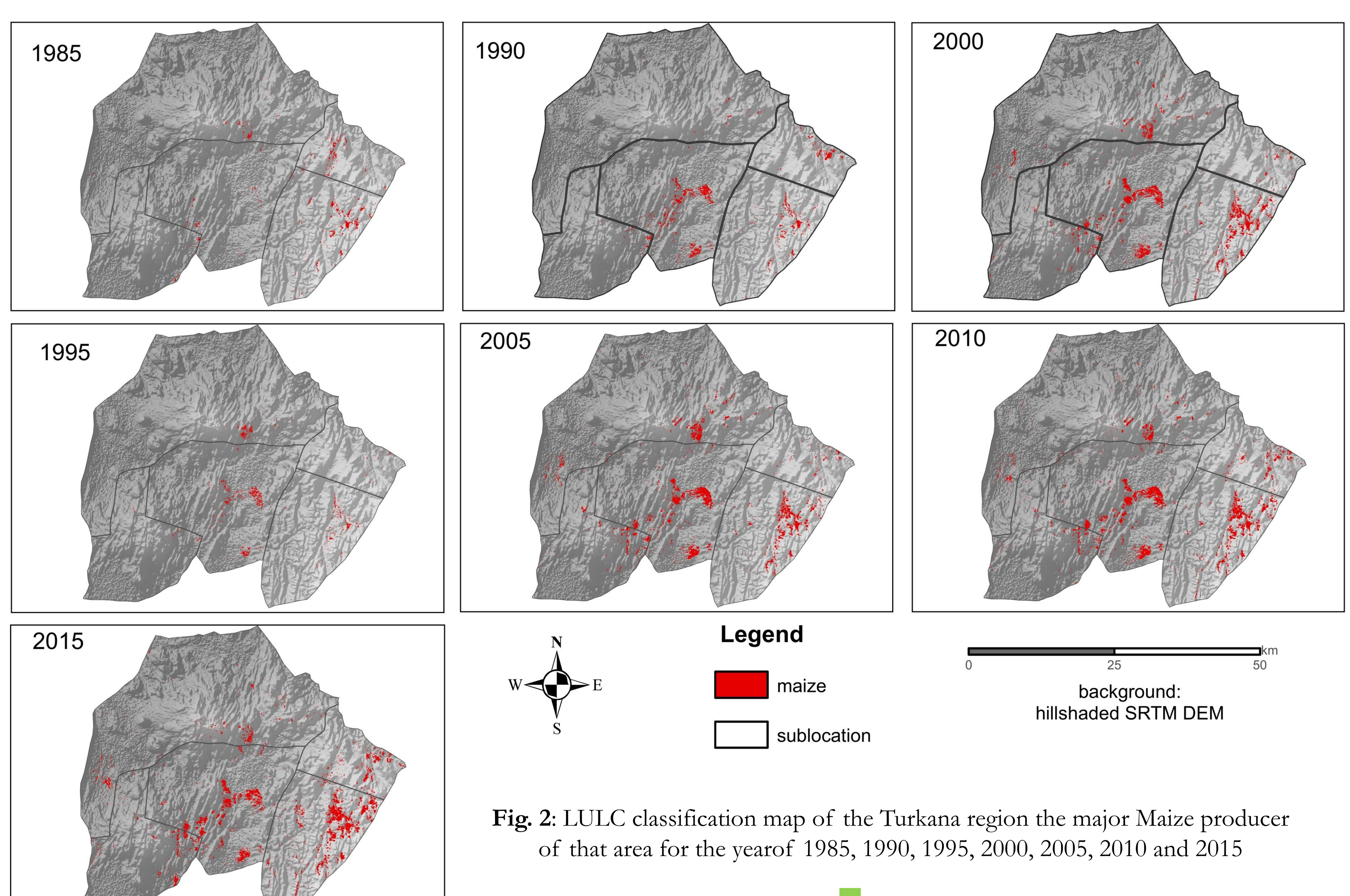

Fig. 2: LULC classification map of the Turkana region the major Maize producer of that area for the yearof 1985, 1990, 1995, 2000, 2005, 2010 and 2015

Data & Methods

- Multispectral Landsat surface reflectance products 4, 5, 7, 8 data for reference years (1985, 1990, 1995, 2000, 2005, 2010 and 2015).
- Masking of Clouds and cloud shadows with a cloud mask (Fmask Algorithm) (Zhu et al. , 2015)
- Field data from various campaigns 2012-2015
- Compositing over three years (reference year ± 1 year, e.g., 2014-2016 for reference year 2015 to combine two or more phenological stages) using multitemporal metrics of spectral bands & spectral indices (intra-annual variation expressed by percentiles)(Mack et al., 2017)
- Tasseled Cap components brightness, greenness and wetness (Crist,1985) and Normalized Difference Vegetation Index (NDVI) used
- Random Forest land use/land cover (LULC) classification with 5 classes
- Accuracy assessment by confusion matrices

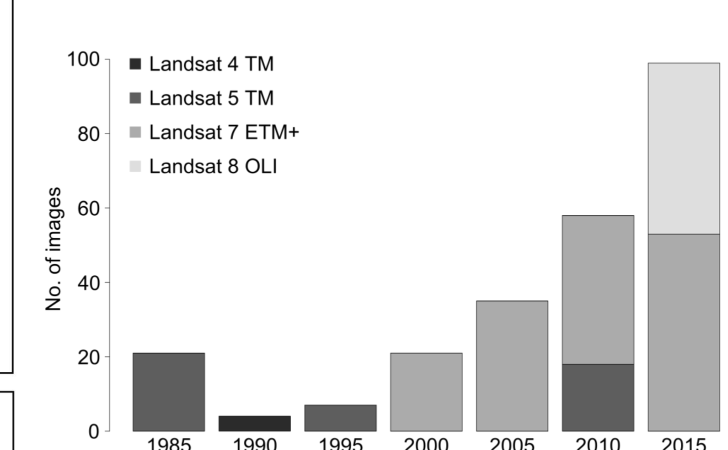

Fig. 3: Data distribution in the study region. The combined availability of Landsat 5/7 in 2010 and Landsat 7/8 in 2015 leads to increased data availability in recent years.

Tab. 1 Acquisition periods of the Landsat images for each reference year

reference year	first acquisition	last acquisition
1985	04.12.1984	30.12.1986
1990	01.03.1989	16.02.1990
1995	17.10.1994	27.04.1995
2000	20.08.1999	12.10.2001
2005	22.01.2004	13.12.2006
2010	03.01.2009	27.12.2011
2015	01.01.2014	14.05.2016

Results

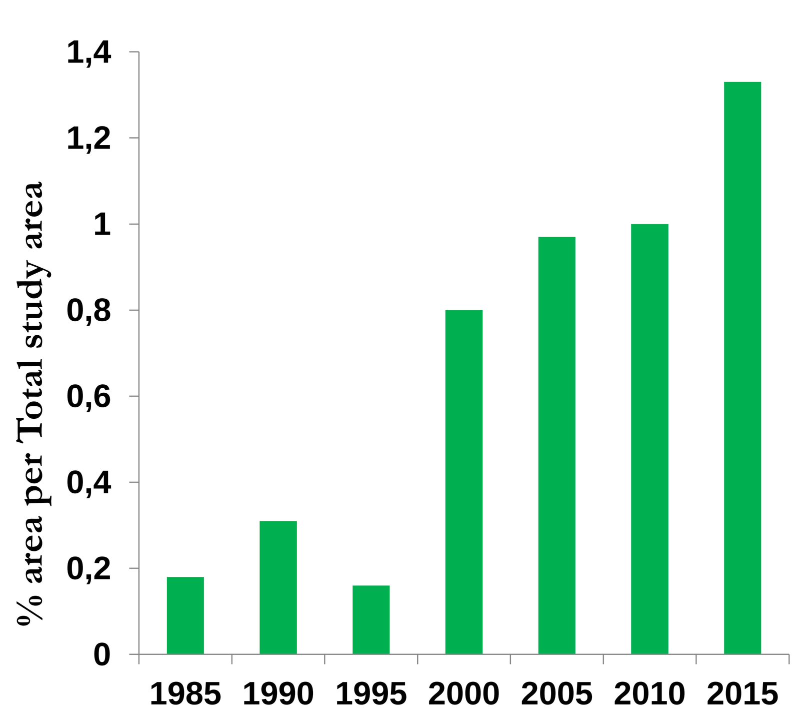

Fig. 4: Increasing **Maize Cultivation area** in the East Pokot and surrounding. from **0.13 % to 1.33% in time span of 30 years**

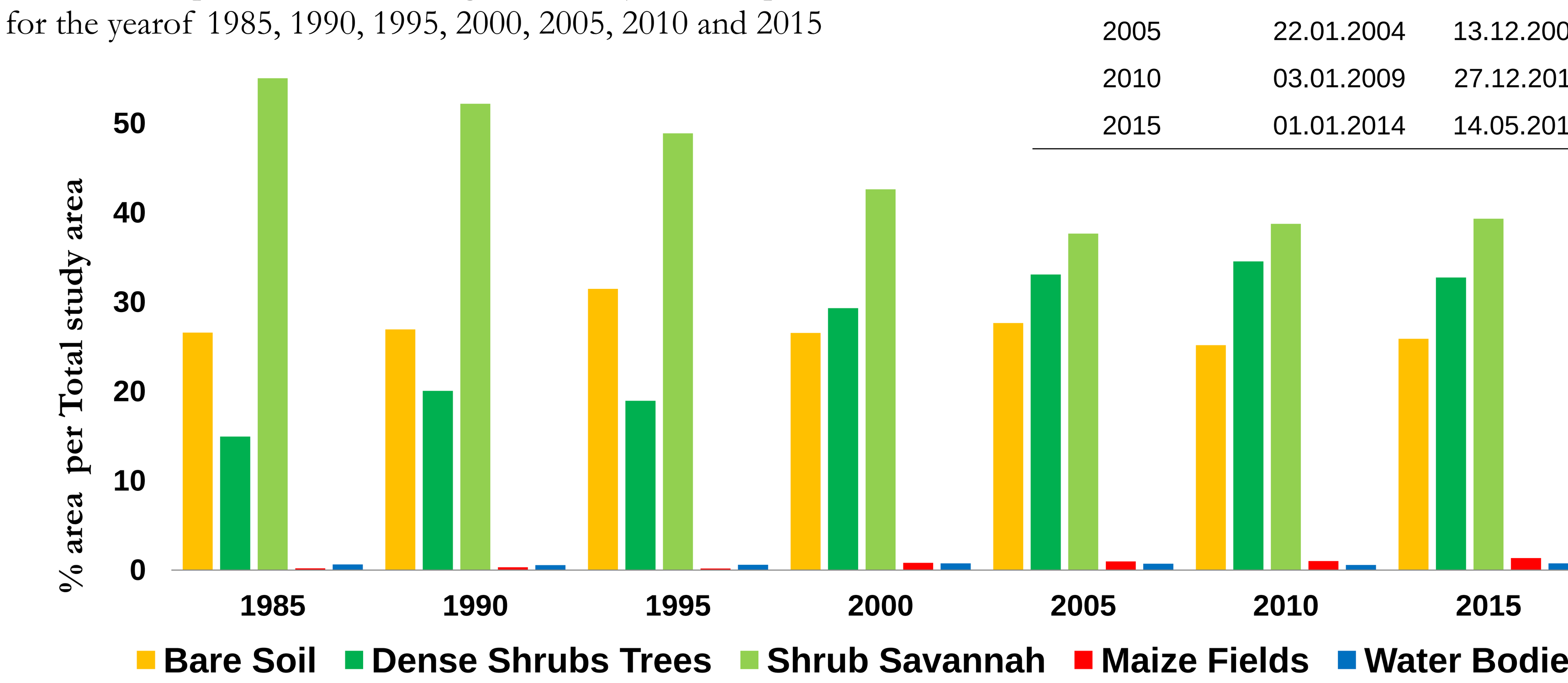

Fig. 5 LULC change in terms of percentage per total Study area for all 5 Classes. From 1985 to 2015, **Dense Shrubs and trees had increased from 14.93 % to 34.53%** of the total area and **Shrub Savannah had decreased from 57.7% to 38.73 %.**

Tab. 2 Confusion matrices of image classified for each years based on the validation data. BS = Bare Soil, DST = Dense Shrubs Trees, SS = Shrub Savanna, MF = Maize Fields, WB = Water Bodies. OA = overall classification accuracy, PA = producer's accuracy, UA = user's accuracy, KA=kappa's accuracy.

(A) Landsat Image Classification 1985 OA (%) = 91.38 KA (%)= 81.3

	BS	DST	SS	MF	WB	Total	UA (%)
BS	359	0	22	0	0	381	94.23
DST	0	31	0	0	0	31	100
SS	23	1	92	1	0	117	78.63
MF	0	0	0	6	0	6	100
WB	0	0	0	0	10	10	100
Total	382	32	114	7	10	545	
PA (%)	93.98	96.88	80.7	85.71	100		

(B) Landsat Image Classification 1990 OA (%) = 92.48 KA (%)= 83.78

	BS	DST	SS	MF	WB	Total	UA (%)
BS	361	1	17	0	0	379	95.25
DST	1	30	0	0	0	31	96.77
SS	20	1	96	0	0	117	82.05
MF	0	0	1	7	0	8	87.5
WB	0	0	0	0	10	10	100
Total	382	32	114	7	10	545	
PA (%)	94.5	93.75	84.21	100	100		

(C) Landsat Image Classification 1995 OA (%) = 90.68 KA (%)= 78.66

Class	BS	DST	SS	MF	WB	Total	UA (%)
BS	401	0	30	0	0	431	93.04
DST	1	29	0	0	0	30	96.67
SS	19	1	88	3	0	111	79.28
MF	1	0	0	8	0	9	88.89
WB	0	0	0	0	9	9	100
Total	422	30	118	11	9	590	
PA (%)	95.02	96.67	74.58	72.73	100		

(D) Landsat Image Classification 2000 OA (%) = 88.59 KA (%)= 78.88

	BS	DST	SS	MF	WB	Total	UA (%)
BS	400	1	34	0	0	435	91.95
DST	0	72	2	0	0	74	97.3
SS	25	12	96	0	0	133	72.18
MF	0	1	1	17	0	19	89.47
WB	0	1	0	0	13	14	92.86
Total	425	87	133	17	13	675	
PA (%)	94.12	82.76	72.18	100	100		

(E) Landsat Image Classification 2005 OA (%) = 89.68 KA (%)= 80.29

	BS	DST	SS	MF	WB	Total	UA (%)
BS	434	1	40	1	0	476	91.18
DST	0	80	11	0	0	91	87.91
SS	11	4	72	2	0	89	80.9
MF	1	0	1	30	0	32	93.75
WB	0	0	0	0	10	10	100
Total	446	85	124	33	10	698	
PA (%)	97.31	94.12	58.06	90.91	100		

(F) Landsat Image Classification 2010 OA (%) = 87.11 KA (%)= 77.6

	BS	DST	SS	MF	WB	Total	UA (%)
BS	429	3	33	0	14	479	89.56
DST	0	99	5	0	7	111	89.19
SS	24	6	79	5	1	115	68.7
MF	0	0	0	47	0	47	100
WB	0	0	0	0	8	8	100
Total	453	108	117	52	30	760	
PA (%)	94.7	91.67	67.52	90.38	26.67		

(G) Landsat Image Classification 2015 OA (%) = 87.55 KA (%)= 78.38

	BS	DST	SS	MF	WB	Total	UA (%)
BS	436	2	26	7	0	471	92.57
DST	0	93	6	0	0	99	93.94
SS	25	13	82	12	0	132	62.12
MF	1	0	3	44	0	48	91.67
WB	0	0	0	0	13	13	100
Total	462	108	117	63	13	763	
PA (%)	94.37	86.11	70.09	69.84	100		

Conclusions

- Analysis of the LULC revealed the Sevenfold increase in maize fields **in last 30 years from 1104.21 ha in 1985 to 8176.14 ha in 2015** signifying that region is gaining swift maize dependency for food security
- The region is under threat with **large amount of bush encroachment** which was clearly visible in classified maps with less availability of shrub savanna and grazing grassland for the pastoralism
- Pastoralists are increasingly transformed from specialized, highly mobile and subsistence-oriented cattle herding to largely sedentary and market oriented keeping of small stock and maize farming.
- In general, all seven LULC maps showed **OA higher than 87% and Kappa coefficient above 0.77** representing strong agreement between assigned pixels and validation reference data. This indicates all the classified images were of high accuracy.
- The methods adopted showed a **significant positive relationship between temporal metrics of spectral reflectance, NDVI and tasseled cap components greenness, wetness and dryness**, indicating the freely available Landsat maps of the 2-3 years span even the images are cloudy offers trustworthy resource assessment and monitoring options for informing planning and interventions in semi-arid regions

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Amit Kumar Basukala
Center for Development Research (ZEF), University of Bonn
Contact: amitbasu@uni-bonn.de, pblkamit@gmail.com, www.zfl.uni-bonn.de, ww.zef.de

Faculty of Humanities
Department of Social and Cultural Anthropology