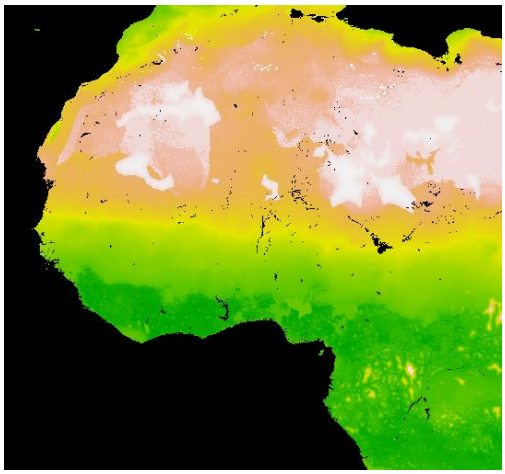
Similarity Analysis

For the Humidtropics Action Area



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Humidtropics, a CGIAR Research Program led by IITA, seeks to transform the lives of the rural poor in tropical America, Asia and Africa. Research organizations involved in core partnership with Humidtropics are AVRDC, Bioversity, CIAT, CIP, FARA, icipe, ICRAF, ILRI, IITA, IWMI and WUR. humidtropics.cgiar.org

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1 Introduction

The Humidtropics program of the CGIAR, aims to help poor farm families in tropical Africa, Asia and Americas to boost their income from integrated agricultural systems' intensification while preserving their land for future generations. Four action areas have been defined, in Eastern Africa, Western Africa, Central America and Mekong area. Each of the action areas is subdivided into action sites. Research in the different action site will be conducted, among other identification of best bet innovation to improve agricultural livelihoods.

Innovations that improve these rural livelihoods work in a particular location but might not be a solution in another location with different characteristics. Understanding the context within which research operates is crucial to understand where else the acquired knowledge can applied and define the out-scaling potential. Up to recent, context was mainly understood as the bio-physical environment, for which full coverage often satellite image derived geographical information exist. However, in complex agricultural systems, uptake and spreading of innovation is often more driven by socio-economic and institutional context than the biophysical environment. It is therefore crucial to define context in a broader way.

Similarity analysis tries to understand these contexts and map them out. It allows addressing two different but complementary questions. First of all, to what extend is a given site similar to another sites? This allows to predict cross-site learning. Secondly, where else in the region can a similar context be found? This allows to define the extent of potential out-scaling of the best bet innovations and lessons learnt.

The objective of this report is present a generic similarity analysis for each of the action sites of the Humid Tropic program and define the out-scaling and cross-site learning potential.

2 Assessing similarity

2.1 Methods to measure similarity

In its simplest term, similarity analysis tries to compare different geographical layers and assess to what extent a point in space is similar to a reference point, also referred to as distance. This computation is then done for every point is space (pixel) in order to get a map. Different methods exist to compare these layers. For this report three of them have been retained, namely (i) Euclidian similarity (ii) Mahalanobis similarity and (iii) Multivariate Environmental Similarity Surfaces.

Euclidian similarity, assess the distance by using the absolute difference, whereas Mahalanobis similarity, takes the distribution of the data into account by measuring how many standard deviations away a given value is away from the reference point. For both methods, the reference point is in fact the average of randomly sampled points within the area for which similarity is computed. Also, as the different layer could be correlated, a principal component analysis is performed and is used as input for Euclidian similarity.

Finally, Multivariate Environmental Similarity Surfaces (MESS) is the most sophisticated method. It is an index that compares the value of a point in space with the distribution of the

randomly sampled reference points. It allows negative values – these are areas where at least one variable has a value that is outside the distribution of the reference points. These areas are referred to as novel environments. To assess similarity we are therefore interested in positive values of this index.

2.2 Assessing out scaling potential and site comparison

We apply these different methods to the Humidtropics action sites: the reference points are sampled within the delineation of an action sites.

The output maps show to what extent the other areas are similar to the reference area, and therefore show the extent of out-scaling potential, including other action sites (that have not been included to reference areas).

In addition, average similarity score for each action site can be computed with a zonal statistic. This returns a quantitative comparison across the different sites. The scale of these similarity scores are dependent on the input data, and therefore is relative to reference site. This means values and conclusions cannot be compared if they have been run for different reference sites. For Euclidian and Mahalanobis the smaller the value the more similar, whereas for Multivariate Environmental Similarity Surfaces (MESS) the higher the value the more similar.

2.3 Input data

Humidtropics program's objective for sustainable intensification calls for a set of variables that can capture the different dimensions of agricultural systems and their capacity to innovate. Humidtropics defines agricultural system with the following dimensions: resource integrity, productivity, markets and institution and equity. Therefore data has been collected along these dimensions as variables that can explain the context. In order to assess all Humidtropics sites in a similar way, we have taken into account only globally available data, which significantly limits the choice. Also some biophysical variables correlate, and therefore have similar pattern, one of them is sufficient to assess similarity. This is for example the case with temperature that correlates with elevation, or rainfall that correlated with NDVI, the greenness index, which correlates with length of growing period. In this case, the variables that capture productivity best have to been chosen. Table 1 shows the selected variables and the corresponding data that has been used to assess the similarity of contexts in the Humidtropics.

Elevation and length of growing season capture the agricultural potential of an area and therefore its productivity. To assess resource integrity, the Human Appropriation of Net Primary Productivity has been use, it measures the amount of net primary production that humans use worldwide in an average year, and then tie it to cultural consumption habits. For market access, travelling time to towns with more than 50 000 inhabitant has been used. Finally to assess equity, poverty based on stunting population as well as density of rural population has been use. The latter, is a proxy of landholding size in the area, and therefore captures the potential for agricultural development.

Table 1 : data used for the similarity analysis

dimension	Variable	Data used	Source
productivity	Elevation	Digital elevation model	(Jarvis et al., 2008)
	Length of growing period	Length of growing period	(IIASA/FAO, 2009)
Resource integrity	Resource integrity	Human Appropriation of Net Primary Productivity	(Imhoff et al., 2004)
Market and institutions	Market access	Travel time to markets with more 50 000 population	(Nelson, n.d.)
Equity	Rural population	Worldpop with extracted urban zone	(Linard et al., 2012) (Schneider et al., 2010)
	poverty	Poverty based on stunting population under 5	(FAO, 2011)

3 Analysis for the Western Africa action sites

3.1 Delineations for West Africa action area

Humidtropics defines three different scales. The action area is the regional scale and consists of a group of action sites. Action sites are usually at country level. Within these action sites, field sites are identified, these are sites in which research will be implemented. These field sites are usually at sub-national level.

The West Africa action area consists of four action sites, namely in Côte d'Ivoire, Ghana, Nigeria and Cameroon shown in Figure 1.

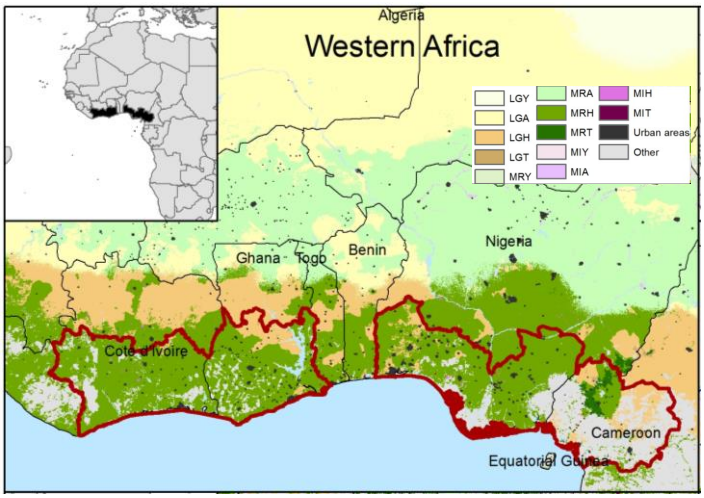

Figure 1 : Western Africa action area and action site delineation visualized on the livestock system map

3.2 Similarity analysis for Côte d'Ivoire

3.2.1 Euclidian similarity

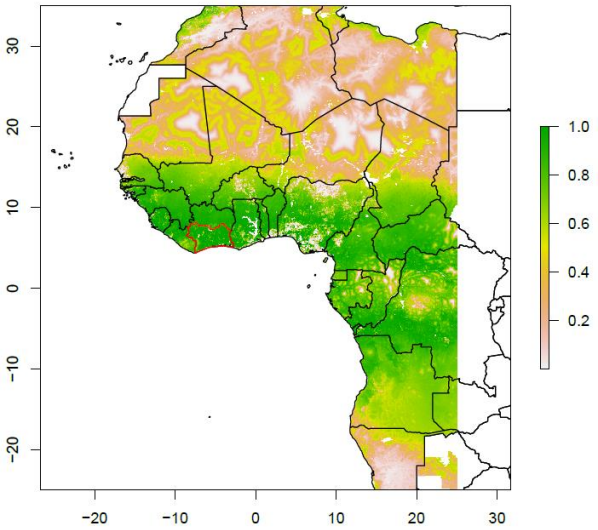

Figure 2 : Euclidian similarity for Cote d'Ivoire

Figure 2 shows the Euclidian similarity for Cote d'Ivoire. The darker the green the more similar are places are with the action site. The darkest green can be found in the areas in immediate proximity to the action site. Also the whole area between 15 latitude North and 5 latitude South is relatively similar with the exception of some pots in Nigeria.

3.2.2 Mahalanobis similarity

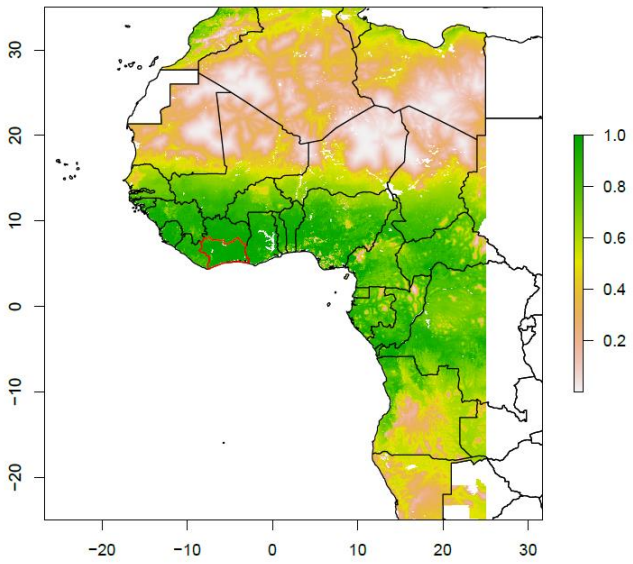

Figure 3 : Mahalanobis similarity for Cote d'Ivoire

Figure 3 shows the Mahalanobis similarity for Cote d'Ivoire. The darker the green the more similar are places are with the action site. The similarity range is pretty similar to the Euclidian similarity.

3.2.3 Multivariate Environmental Similarity Surfaces

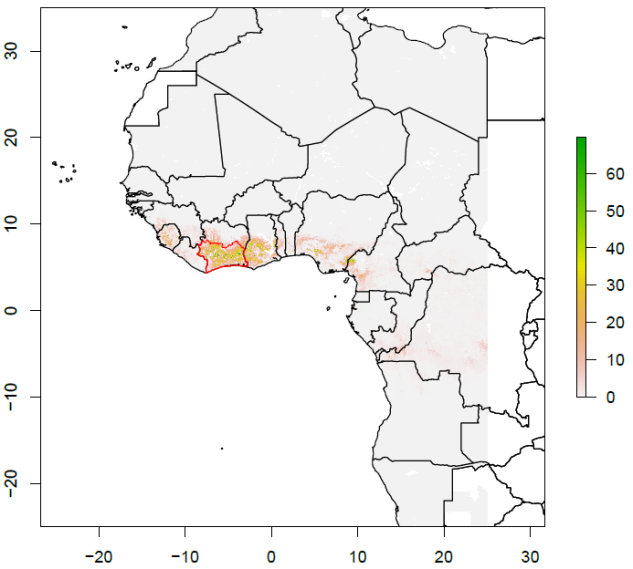

Figure 4 : Multivariate Environmental Similarity Surfaces for Cote d'Ivoire

Figure 4 shows the Multivariate Environmental Similarity Surfaces for Cote d'Ivoire. The colored area suggests places where similar distributions of the different variables can be found and there for are similar to the study site. This similarity is much more selective and identifies areas in Ghana and some in Nigeria.

3.2.4 Comparison of the other action sites with Cote d'Ivoire

Table 2 suggest that Ghana is the most similar site to Cote d'Ivoire, as for both Euclidian and Mahalanobis similarity display the lowest value. Whereas Nigeria and Cameroon seem quite similar looking at Euclidian distance, the Mahalanobis suggest they are quite different.

Table 2 : comparison of similarity for the Western African Sites compared to Cote d'Ivoire

	Euclidian	Mahalanobis	Mess positives only	Mess
Cameroon	0.030	37.81	3.59	-1.38
Ghana	0.027	8.78	11.53	11.11
Nigeria	0.059	35.14	3.667	-3.33

The Multivariate Environmental Similarity suggests that only Ghana is similar. Also the negative value for Cameroon and Nigeria suggests that at least one of the variable lies outside the distribution in Cote d'Ivoire and therefore are different. The small difference between the positive only and the full Multivariate Environmental Similarity suggest that only very few areas in Ghana are outside the Cote d'Ivoire distribution and therefore can be considered as similar.

3.3 Similarity analysis for Ghana

3.3.1 Euclidian similarity

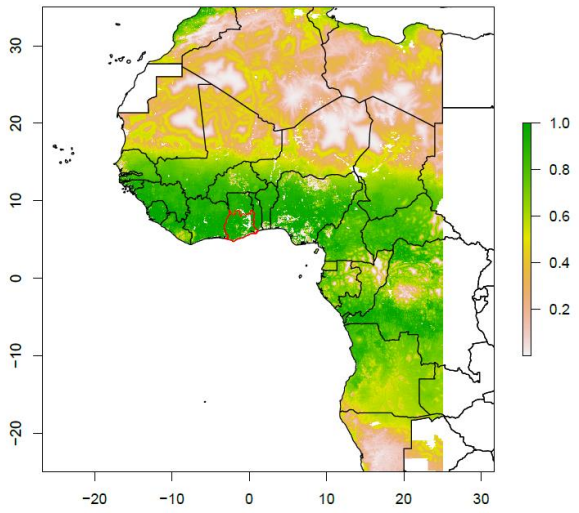

Figure 5 : Euclidian similarity for Ghana

Figure 5 shows the Euclidian similarity for Ghana. The darker the green the more similar are places are with the action site. Similarly to Cote d'Ivoire, the darkest green can be found in the areas in immediate proximity to the action site. Also the whole area between 15 latitude North and 5 latitude South is relatively similar with the exception of some pots in Nigeria and in the Republic of Congo.

3.3.2 Mahalanobis similarity

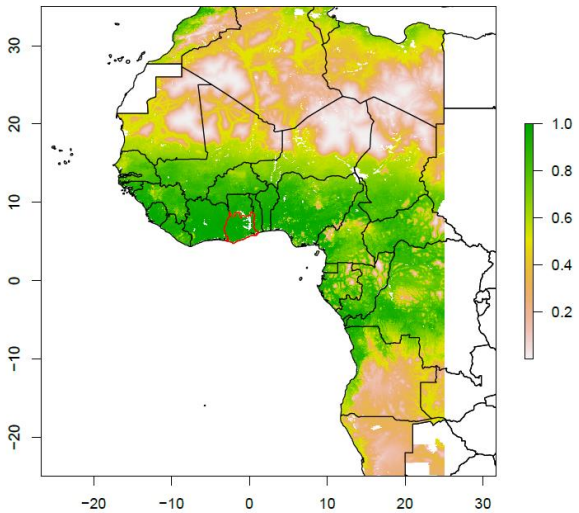

Figure 6 : Mahalanobis similiarity for Ghana

Figure 6 shows the Mahalanobis similarity for Ghana. The darker the green the more similar are places are with the action site. The similarity range is pretty similar to the Euclidian similarity.

3.3.3 Multivariate Environmental Similarity Surfaces

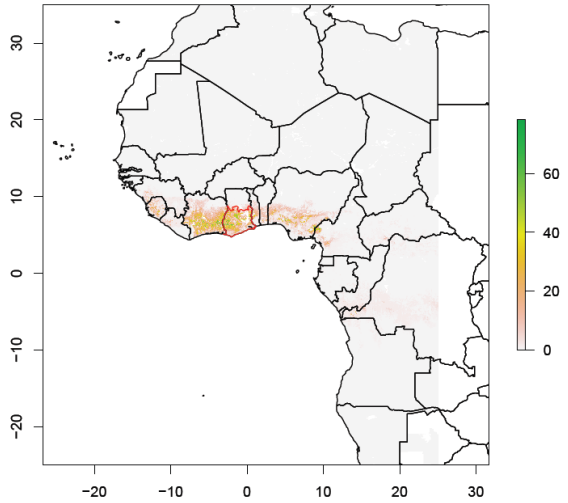

Figure 7 : Multivariate Environmental Similarity Surfaces for Ghana

Figure 7 shows the Multivariate Environmental Similarity Surfaces for Ghana. The colored area suggests places where similar distributions of the different variables can be found and there for are similar to the study site. This similarity is much more selective and identifies areas in Cote d'Ivoire and some in Nigeria.

3.3.4 Comparison

Table 3 suggest that Cote d'Ivoire is the most similar site to Ghana, as for both Euclidian and Mahalanobis similarity display the lowest value. Whereas Nigeria and Cameroon seem quite similar looking at Euclidian distance, the Mahalanobis suggest they are quite different.

Table 3 comparison of similarity for the Western African Sites compared to Ghana

	Euclidian	Mahalanobis	MESS positives only	MESS
Cameroon	0.037	52.12	2.92	-12.08
Cote d'Ivoire	0.024	9.38	16.88	15.65
Nigeria	0.050	34.58	6.37	4.48

The Multivariate Environmental Similarity suggests that Cote d'Ivoire is quite similar. Nigeria still has a positive value suggesting that distribution of the variable are still comparable with Ghana, whereas Cameroon lies outside of the distribution of the reference variables and therefore has to be considered as different.

3.4 Similarity analysis for Nigeria

3.4.1 Euclidian similarity

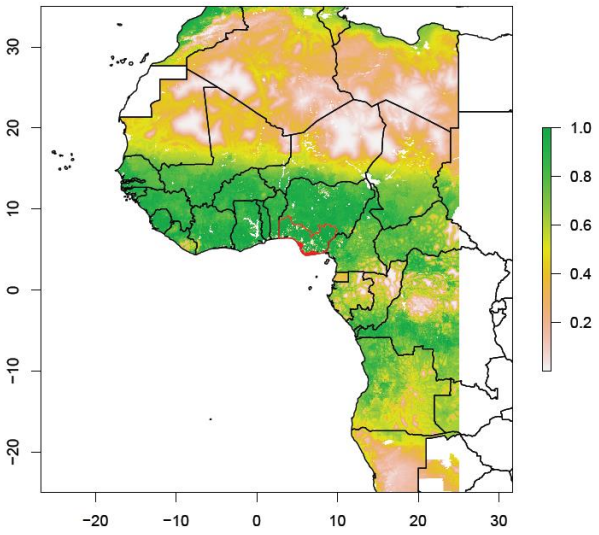

Figure 8 : Euclidian similarity for Nigeria

Figure 8 shows the Euclidian similarity for Nigeria. The darker the green the more similar are places are with the action site. Similarly to Cote d'Ivoire, the darkest green can be found in the areas in immediate proximity to the action site. However the similarity range extends more to the West and less to the South than the similarity for Ghana or Cote d'Ivoire.

3.4.2 Mahalanobis similarity

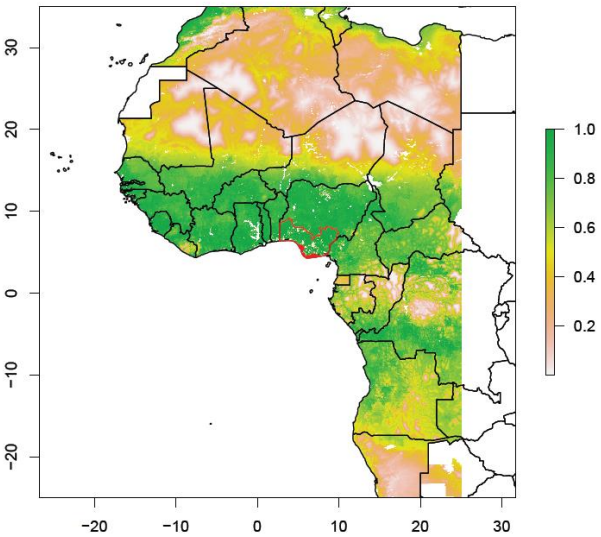

Figure 9 : Mahalanobis similarity for Nigeria

Figure 9 shows the Mahalanobis similarity for Nigeria. The darker the green the more similar are places are with the action site. The similarity range is pretty similar to the Euclidian similarity.

3.4.3 Multivariate Environmental Similarity Surfaces

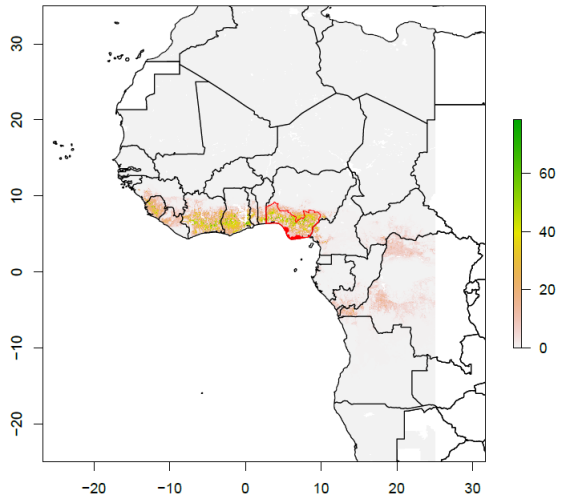

Figure 10 : Multivariate Environmental Similarity Surfaces for Nigeria

Figure 10 shows the Multivariate Environmental Similarity Surfaces for Nigeria. The colored area suggests places where similar distributions of the different variables can be found and there for are similar to the action site. This similarity is much more selective and identifies areas and Cote d'Ivoire as well as Sierra Leone.

3.4.4 Comparison

Table 4 suggests that Cote d'Ivoire and Ghana are quite similar to Nigeria consistently across all measurement, whereas Cameroon is quite different.

Table 4 : comparison of similarity for the Western African Sites compared to Nigeria

	Euclidian	Mahalanobis	MESS positives only	MESS
Cameroon	0.061	40.64	3.12	2.23
Cote d'Ivoire	0.050	5.49	16.94	16.68
Ghana	0.040	4.31	20.67	20.67

Note that this analysis concludes that Nigeria is quite similar to Cote d'Ivoire and Ghana. However the analysis for Cote d'Ivoire and Ghana suggest that these two sites are quite different from Nigeria. Remind, these measurement are always relative to the reference site, and in this particular case, the results implies that Nigeria is a more heterogeneous action site, and therefore more sites are similar to it than for more homogenous sites.

3.5 Similarity analysis for Cameroon

3.5.1 Euclidian similarity

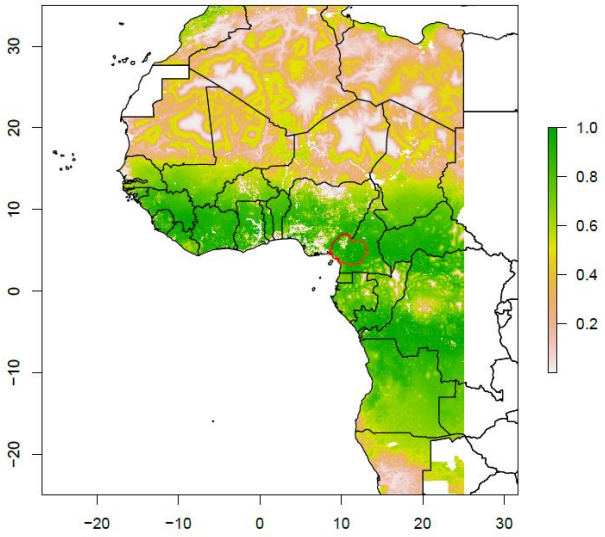

Figure 11 : Euclidian similarity for Cameroon

Figure 11 shows the Euclidian similarity for Cameroon. The darker the green the more similar are places are with the action site. Cameroon is therefore quite similar Ghana and Cote d'Ivoire as well as all the countries Western to these latter, however is quite different to Nigeria.

3.5.2 Mahalanobis similarity

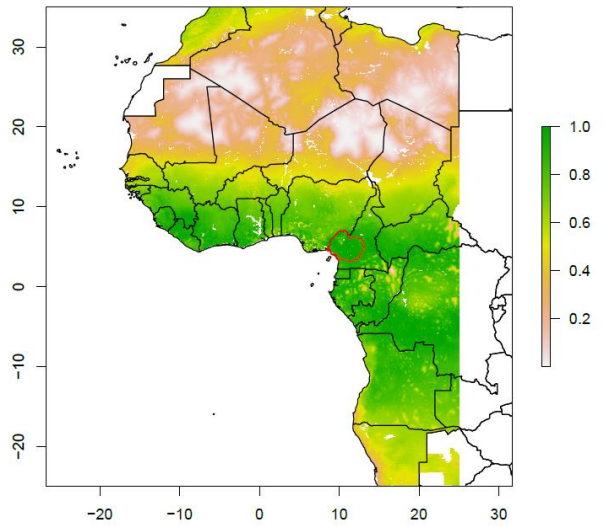

Figure 12 : Mahalanobis similarity for Cameroon

Figure 12 shows the Mahalanobis similarity for Nigeria. The darker the green the more similar are places are with the action site. The similarity range is pretty similar to the Euclidian similarity, however Nigeria seems to less different.

3.5.3 Multivariate Environmental Similarity Surfaces

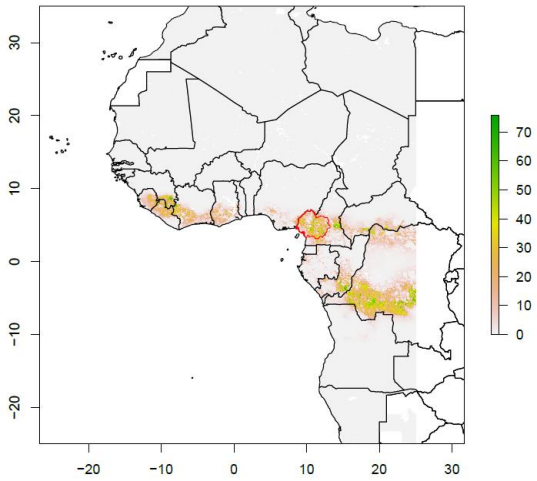

Figure 13 : Multivariate Environmental Similarity Surfaces for Cameroon

Figure 13 shows the Multivariate Environmental Similarity Surfaces for Cameroon. The colored area suggests places where similar distributions of the different variables can be found and there for are similar to the action site. This similarity is much more selective and identifies areas and the action sites in Ghana and Cote d'Ivoire as well as Sierra Leone and parts of Liberia and the West of the Republic of Congo. It is clearly different from Nigeria.

3.5.4 Comparison

Table 4 suggests that Cote d'Ivoire and Ghana are quite similar to Cameroon consistently across all measurement, whereas Nigeria is quite different.

Table 5 : comparison of similarity for the Western African Sites compared to Cameroon

	Euclidian	Mahalanobis	MESS positive only	MESS
Cote d'Ivoire	0.025	8.92	10.50	9.93
Ghana	0.033	12.42	7.12	6.49
Nigeria	0.065	31.74	2.03	-0.16

Note that this analysis concludes that Cameroon is quite similar to Cote d'Ivoire and Ghana. All analysis suggests that Cameroon and Nigeria are quite different, though both of them seem to be quite similar to Cote d'Ivoire and Ghana. This is due that the fact that the similarity a relative term to the action site selected.

3.6 Conclusion for Western Africa

Ghana and Cote d'Ivoire action sites are consistently similar to each other. Cameroon is consistently different to Nigeria. The overall analysis suggest that Ghana and Cote d'Ivoire are similar to each other. Nigeria and Cameroon are both unique and not comparable nor to each other nor to Ghana or Cote d'Ivoire.

4 Analysis for the Eastern Africa action sites

4.1 Site delineation of Eastern Africa action sites

The East Africa action area consists of five action sites, namely in Ethiopia, Kenya, Uganda, Rwanda, Burundi and Democratic Republic of Congo as shown in Figure 14.

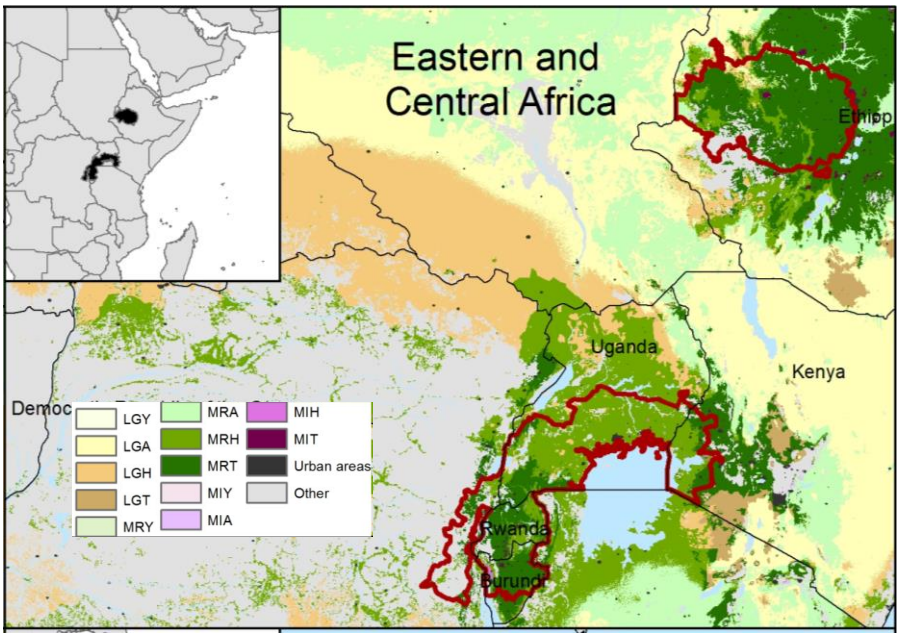

Figure 14 : Eastern Africa action area and action site delineation visualized on the livestock system map

4.2 Similarity analysis for Burundi

4.2.1 Euclidian similarity

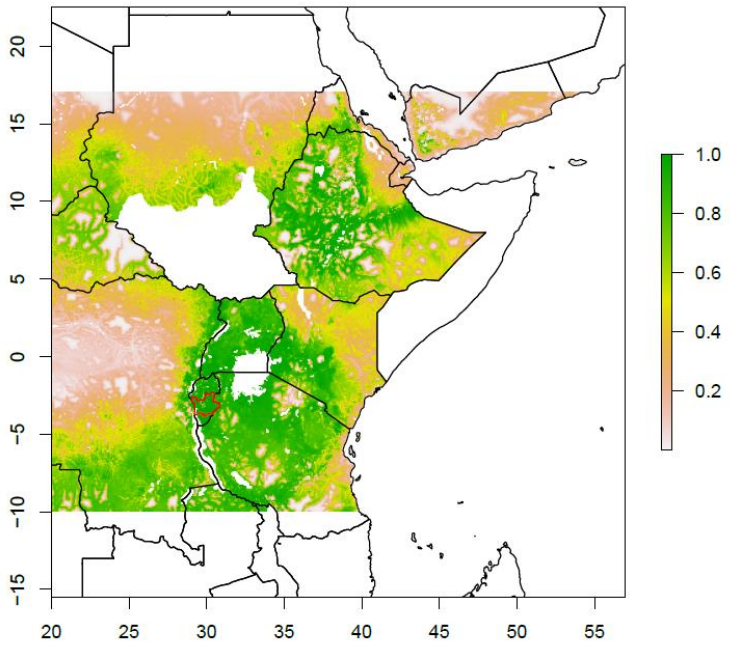

Figure 15 : Euclidian similarity for Burundi

Figure 15 : Euclidian similarity for Burundi shows the Euclidian similarity for Burundi. The darker the green the more similar are places are with the action site. Burundi is therefore quite similar to all the areas around Lake Victoria as well parts of Ethiopia.

4.2.2 Mahalanobis similarity

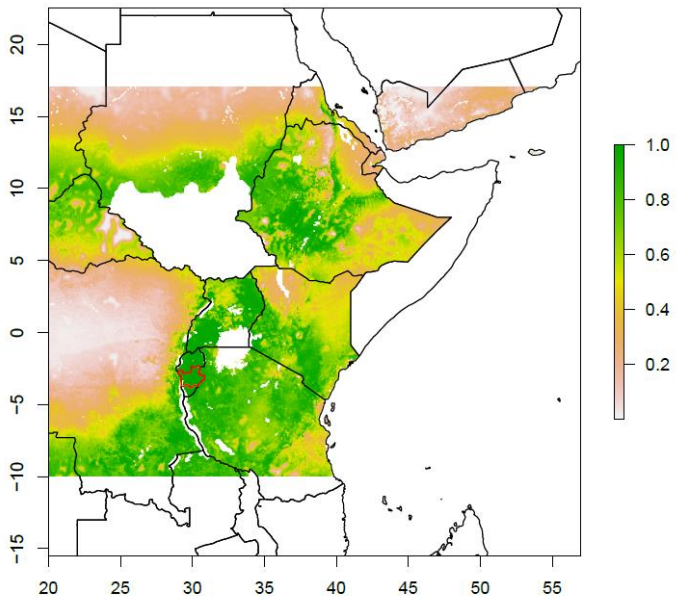

Figure 16 : Mahalanobis similarity for Burundi

Figure 16 shows the Mahalanobis similarity for Burundi. The darker the green the more similar are places are with the action site. The similarity range is pretty similar to the Euclidian similarity.

4.2.3 Multivariate Environmental Similarity Surfaces

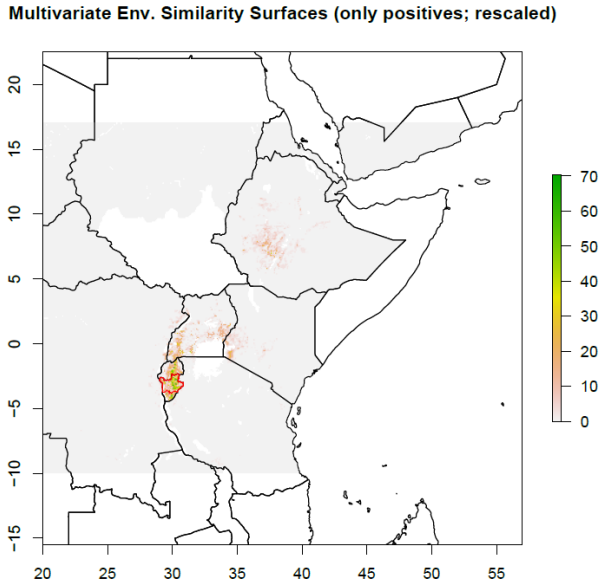

Figure 17 : Multivariate Environmental Similarity Surfaces for Burundi

Figure 17 shows the Multivariate Environmental Similarity Surfaces for Burundi. The colored area suggests places where similar distributions of the different variables can be found and there for are similar to the action site. This similarity is much more selective and identifies areas and the Rwanda and some parts of Uganda, as well as a very small spot in the Kenyan action site.

4.2.4 Comparison

Table 6 suggests that Rwanda and Kenya is the most similar site to Burundi based on the Euclidian similarity, and mainly Rwanda based on the Mahalanobis and multivariate environmental surface similarity. Also the multivariate environmental surface similarity suggests that the Democratic Republic of Congo and Ethiopia are very different (due to the negative values).

Table 6 : comparison of similarity for the Eastern African Sites compared to Burundi

	Euclidian	Mahalanobis	Mess positive only	Mess
DRC	0.121	85.27	0.777	-20.18
Ethiopia	0.115	47.03	1.22	-16.88
Kenya	0.075	40.12	4.52	2.34
Rwanda	0.082	12.52	10.85	8.91
Uganda	0.094	33.00	4.20	1.20

4.3 Similarity analysis for the Democratic Republic of Congo

4.3.1 Euclidian similarity

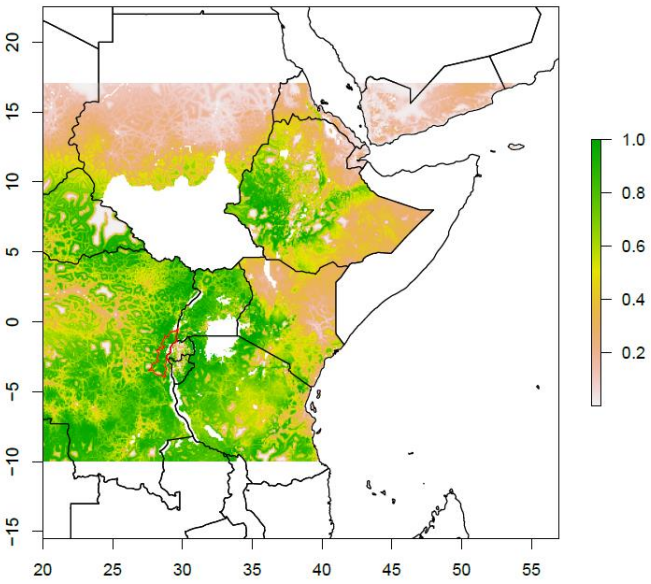

Figure 18 : Euclidian similarity for the Democratic Republic of Congo

Figure 18 shows the Euclidian similarity for the Democratic Republic of Congo . The darker the green the more similar are places are with the action site. The Democratic Republic of Congo is therefore quite similar to all the areas around Lake Victoria as well parts of Ethiopia, except for Rwanda and some spots in Burundi.

4.3.2 Mahalanobis similarity

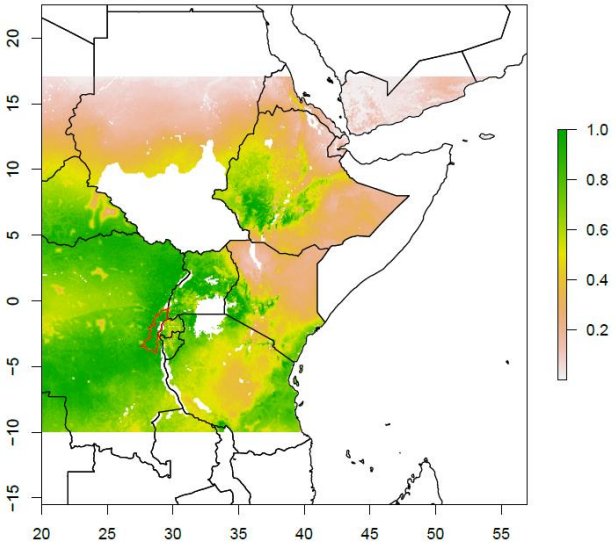

Figure 19 : Mahalanobis similarity for the Democratic Republic of Congo

Figure 19 shows the Mahalanobis similarity for the Democratic Republic of Congo. The darker the green the more similar are places are with the action site. The similarity range is pretty similar to the Euclidian similarity. However the Burundi and Rwanda seem to be more similar than with Euclidian similarity. Also Ethiopia seems less similar than with Euclidian similarty.

4.3.3 Multivariate Environmental Similarity Surfaces

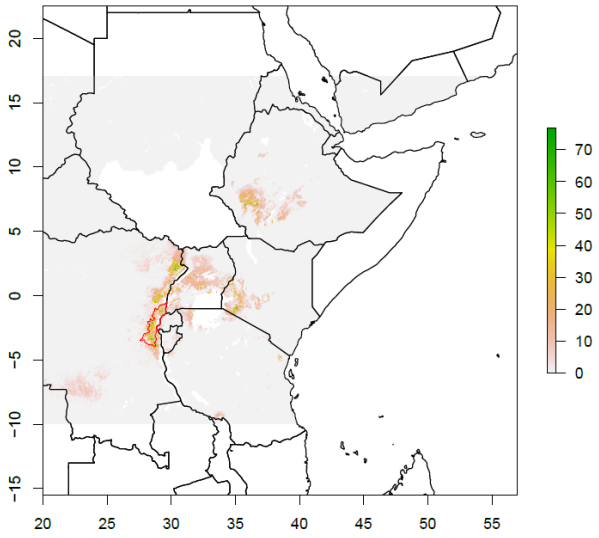

Figure 20 : Multivariate Environmental Similarity Surfaces for Democratic Republic of Congo

Figure 20 shows the Multivariate Environmental Similarity Surfaces for the Democratic Republic of Congo. The colored area suggests places where similar distributions of the different variables can be found and there for are similar to the action site. This similarity is much more selective. It interestingly suggests that the action sites around the lake Victoria are not similar, also only spots of the Ethiopian action area are similar.

4.3.4 Comparison

Table 7 suggests that Ethiopia and Uganda is the most similar site to the Democratic republic of Congo based on the Euclidian similarity. However, Kenya seems to be most similar based on the other similarity methods. Especially the multivariate environmental surface similarity suggest that only Kenya falls in a similar distribution of the variables than the Democratic Republic of Congo.

Table 7 : comparison of similarity for the Eastern African Sites compared to Democratic Republic of Congo

	Euclidian	Mahalanobis	Mess positive only	MESS
Burundi	0.112	24.89	0.860	-6.60
Ethiopia	0.099	24.91	1.71	-15.61
Kenya	0.103	14.89	5.21	4.01
Rwanda	0.130	27.09	0.826	-5.02
Uganda	0.092	16.09	5.00	-1.93

4.4 Similarity analysis for Ethiopia

4.4.1 Euclidian similarity

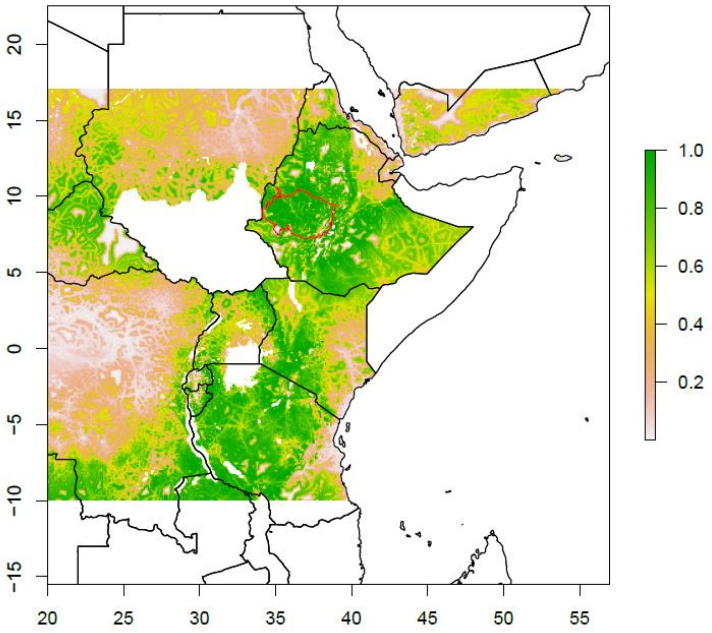

Figure 21 : Euclidian similarity for Ethiopia

Figure 21 shows the Euclidian similarity for Ethiopia. The darker the green the more similar are places are with the action site. Ethiopia is therefore quite similar to all the areas South of Lake Victoria but less to any other Humidtropics action site around the Lake Victoria.

4.4.2 Mahalanobis similarity

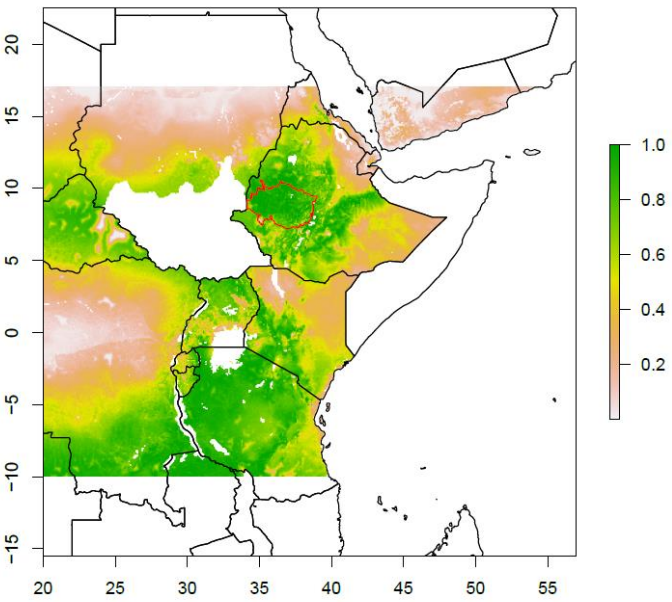

Figure 22 : Mahalanobis similarity for Ethiopia

Figure 22 shows the Mahalanobis similarity for Ethiopia. The darker the green the more similar are places are with the action site. Similarly to the Euclidian similarity, mainly the Ethiopian highland and the area South of Lake Victoria is quite similar. However the Humidtropics action sites around lake Victoria seem more similar than with the Euclidian similarity. Also The Democratic Republic of Congo looks quite different.

4.4.3 Multivariate Environmental Similarity Surfaces

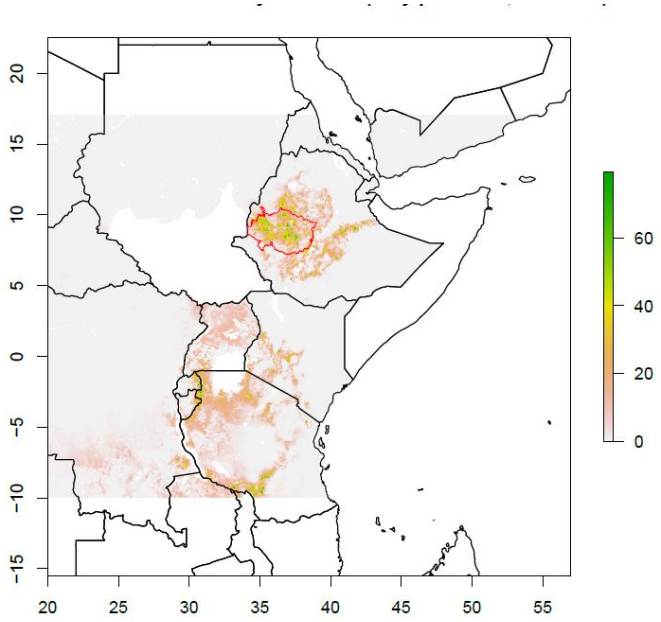

Figure 23 : Multivariate Environmental Similarity Surfaces for Ethiopia

Figure 20 shows the Multivariate Environmental Similarity Surfaces for Ethiopia This similarity is much more selective and that Ethiopian action site is quite unique. Only few pots are similar, mainly in the South of Lake Victoria, and some spots within the other action sites around lake Victoria. The Democratic Republic of Congo is not similar.

4.4.4 Comparison

Table 8 shows the comparison of the Humidtropics sites with Ethiopia. For Euclidian and Mahalanobis similarity, all sites have similar values, quite different from zero, therefore suggesting that all sites are quite different. Based on MESS, sites are not very similar either, however on DRC lies completely out of the distribution of the variables.

Table 8 : comparison of similarity for the Eastern African Sites compared to Ethiopia

	Euclidian	Mahalanobis	Mess positive only	MESS
Burundi	0.107	16.18	5.84	3.97
DRC	0.107	22.73	0.918	-11.96
Kenya	0.120	18.95	4.51	0.900
Rwanda	0.124	19.06	6.58	3.03
Uganda	0.117	20.94	5.06	0.525

4.5 Similarity analysis for Kenya

4.5.1 Euclidian similarity

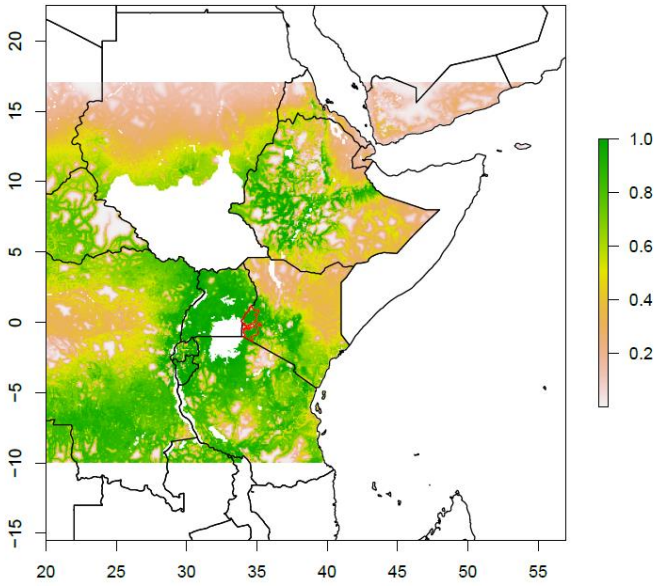

Figure 24 : Euclidian similarity for Kenya

Figure 24 shows the Euclidian similarity Kenya. The darker the green the more similar are places are with the action site. Kenya is therefore quite similar to all the areas around Lake Victoria as well parts of Ethiopia. Only the Democratic Republic of Congo is quite different. Also in the Ethiopian highlands are similar.

4.5.2 Mahalanobis similarity

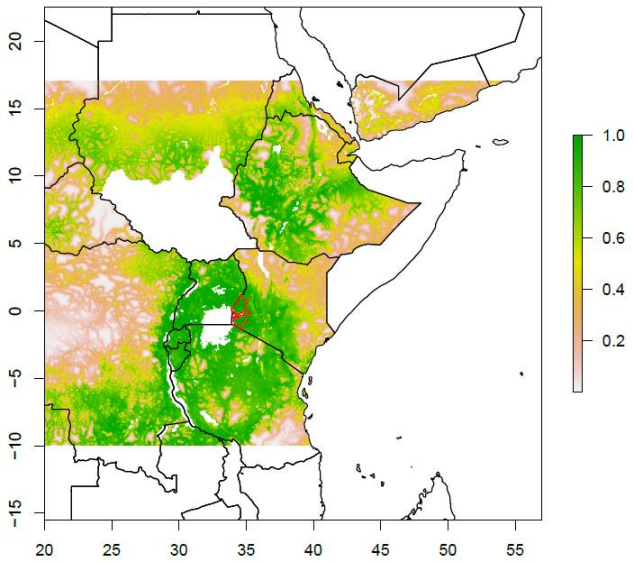

Figure 25 : Mahalanobis similarity for Kenya

Figure 25 shows the Mahalanobis similarity for Kenya. The darker the green the more similar are places are with the action site. Similarly to the Euclidian similarity, the areas around Lake Victoria are most similar as well as some spots in Ethiopia. Also the Democratic Republic of Congo looks quite different.

4.5.3 Multivariate Environmental Similarity Surfaces

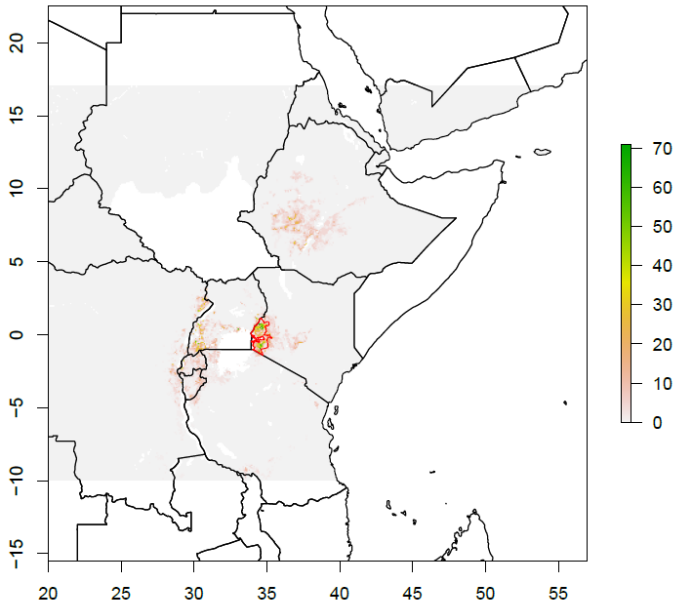

Figure 26 : Multivariate Environmental Similarity Surfaces for Kenya

Figure 26 shows the Multivariate Environmental Similarity Surfaces for Ethiopia. This similarity is much more selective and suggests that the Kenyan action site is quite unique. Only few pots are similar, mainly in the East of Uganda, Burundi and Rwanda.

4.5.4 Comparison

Table 9 shows the comparison of the Humidtropics sites with Kenya. In terms of Euclidian and Mahalanobis similarity Rwanda seems to be the most similar site, closely followed by Burundi. These two sites are also the only two ones that are suggested to be similar by the MESS.

Table 9 : comparison of similarity for the Eastern African Sites compared to Kenya

	Euclidian	Mahalanobis	Mess positive only	MESS
Burundi	0.077	23.90	2.79	1.56
DRC	0.103	44.88	1.98	-3.76
Ethiopia	0.122	48.46	1.77	-7.37
Rwanda	0.096	19.98	3.48	3.16
Uganda	0.071	14.69	3.51	-0.47

4.6 Similarity analysis for Rwanda

4.6.1 Euclidian similarity

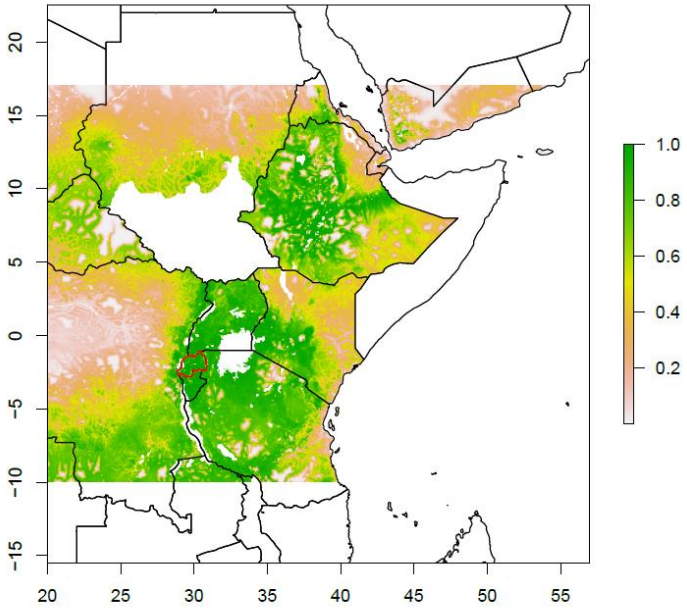

Figure 27 : Euclidian similarity for Rwanda

Figure 27 shows the Euclidian similarity Rwanda . The darker the green the more similar are places are with the action site. Kenya is therefore quite similar to all the areas around Lake Victoria as well parts of Ethiopia.

4.6.2 Mahalanobis similarity

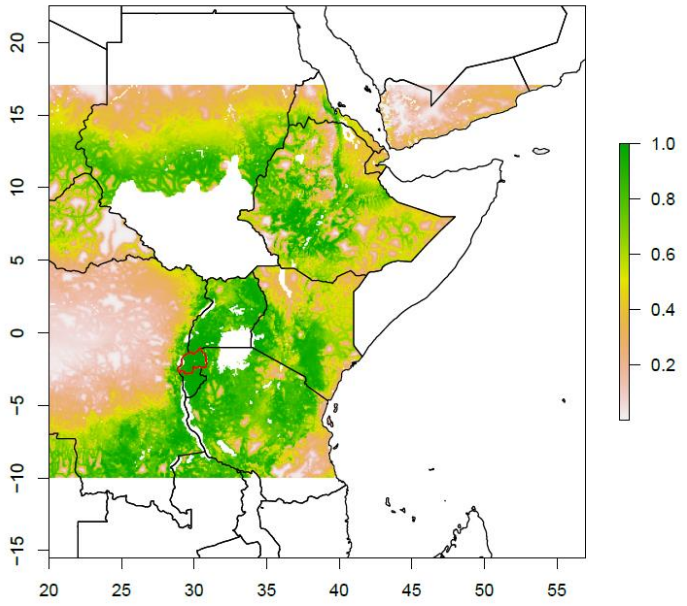

Figure 28 : Mahalanobis similarity for Rwanda

Figure 28 shows the Mahalanobis similarity for Kenya. The darker the green the more similar are places are with the action site. Similarly to the Euclidian similarity, the areas around Lake Victoria are most similar as well as some spots in Ethiopia.

4.6.3 Multivariate Environmental Similarity Surfaces

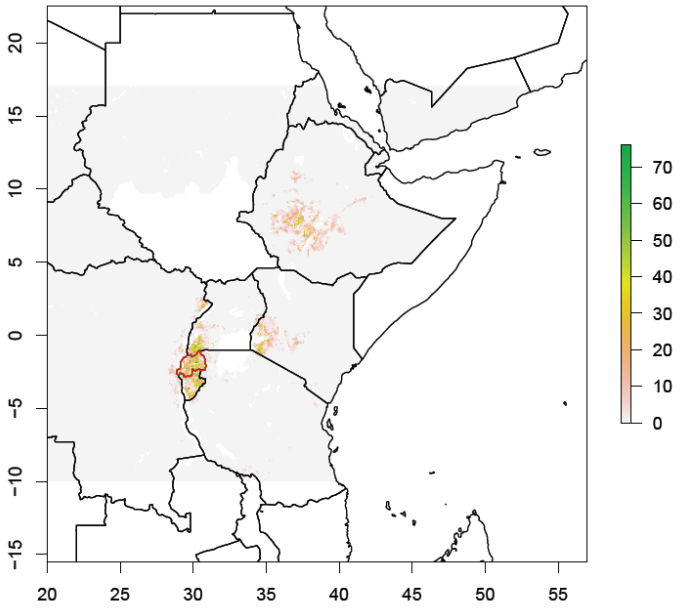

Figure 29 : Multivariate Environmental Similarity Surfaces for Rwanda

Figure 29 shows the Multivariate Environmental Similarity Surfaces for Rwanda. This similarity is much more selective and suggests that the Rwandan action site is similar to the Burundi and the Kenyan action sites as well as some spots in Ethiopia.

4.6.4 Comparison

Table 10 shows the comparison of the Humidtropics sites with Rwanda. In terms of Euclidian and Mahalanobis similarity Burundi and Kenya seems to be the most similar site. These two sites are also the only two ones that are suggested to be similar by the MESS.

Table 10 : comparison of similarity for the Eastern African Sites compared to Rwanda

	Euclidian	Mahalanobis	Mess positive only	MESS
Burundi	0.067	5.72	14.46	12.98
DRC	0.125	32.61	1.82	-8.14
Ethiopia	0.117	28.96	2.93	-9.35
Kenya	0.080	12.83	8.13	6.28
Uganda	0.102	15.10	3.96	-3.00

4.7 Similarity analysis for Uganda

4.7.1 Euclidian similarity

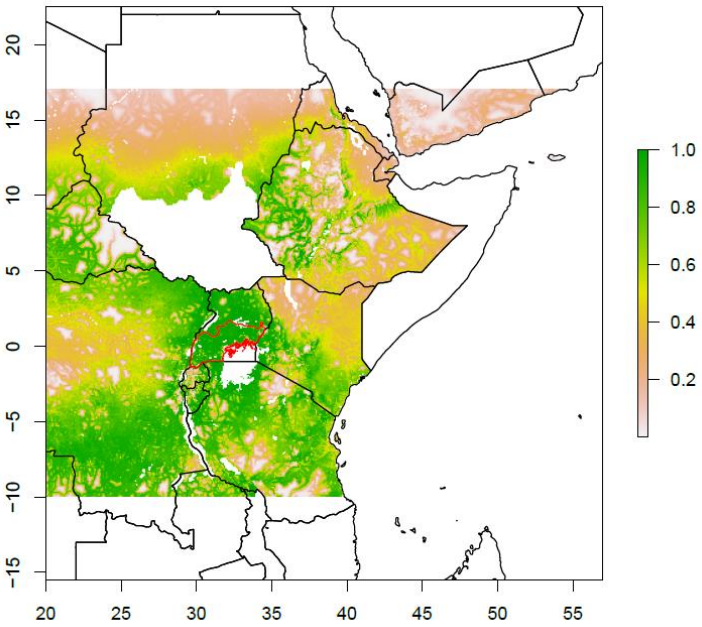

Figure 30 : Euclidian similarity for Uganda

Figure 31 : Mahalanobis similarity for shows the Euclidian similarity Uganda. The darker the green the more similar are places are with the action site. Kenya is therefore quite similar to the Kenyan action site and the Burundi action site, as well as small spots of the Ethiopian site.

4.7.2 Mahalanobis similarity

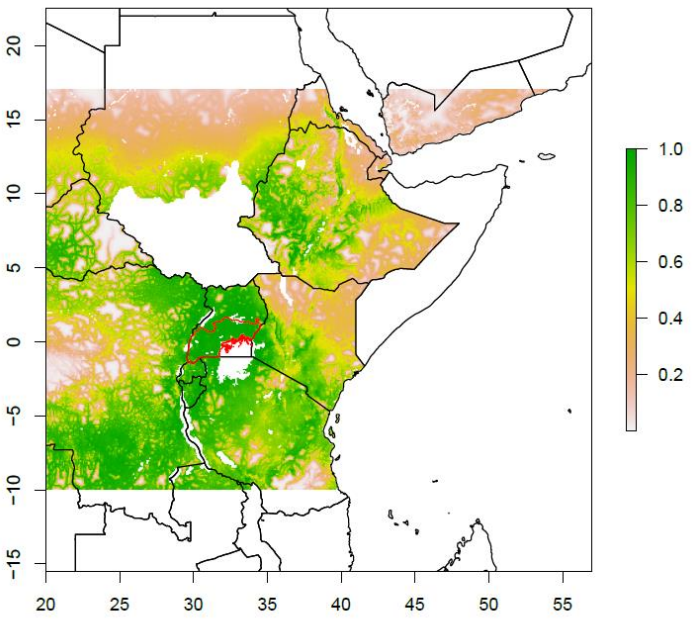

Figure 31 : Mahalanobis similarity for Uganda

Figure 27Figure 31 shows the Mahalanobis similarity for Uganda. The darker the green the more similar are places are with the action site. The similarity is now extended to all the action sites around lake Victoria including the site in the Democratic Republic of Congo.

4.7.3 Multivariate Environmental Similarity Surfaces

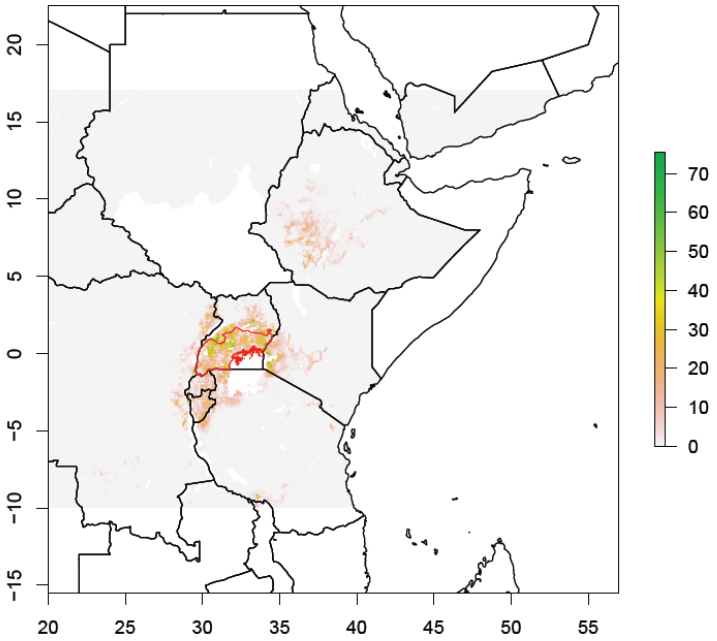

Figure 32 : Multivariate Environmental Similarity Surfaces for Uganda

Figure 31 shows the Multivariate Environmental Similarity Surfaces for Uganda. This similarity is much more selective and suggests that the Ugandan action site is similar to the Burundi and partly of Rwanda as well as some spots in Ethiopia.

4.7.4 Comparison

Table 11 shows the comparison of the Humidtropics sites with Uganda. In terms of Euclidian and Mahalanobis similarity Kenya is the most similar site, followed by Burundi and Democratic Republic of Congo.

Table 11 : comparison of similarity for the Eastern African Sites compared to Uganda

	Euclidian	Mahalanobis	Mess positive only	MESS
Burundi	0.092	11.51	9.07	8.85
DRC	0.091	24.46	4.00	0.98
Ethiopia	0.117	33.16	2.24	-3.21
Kenya	0.066	8.79	14.41	14.29
Rwanda	0.115	14.64	6.41	6.33

When looking at MESS only Ethiopia is totally out of the Ugandan variable distribution, whereas Kenya, Burundi and Rwanda are quite similar.

4.8 Conclusion for Eastern Africa

Often three actions sites bordering Lake Victoria, namely Kenya, Burundi and Rwanda are considered as similar. However Uganda sometimes is considered different. The Democratic Republic of Congo as well as Ethiopia most often turn out to be different and therefore can be considered as unique.

5 Analysis for the Mekong action sites

5.1 Site delineation Mekong action sites

The Mekong action area consists of three action sites, referred to as triangles, which each of them is cross boundary as shown in Figure 33. Triangle 1 is referred to as development triangle and encompasses parts of Vietnam Laos and Cambodia. Triangle 2 is referred to as golden triangle and encompasses areas of Laos, Thailand, Burma and China. Finally triangle 3 is referred to as green triangle and encompasses Vietnam China and Laos.

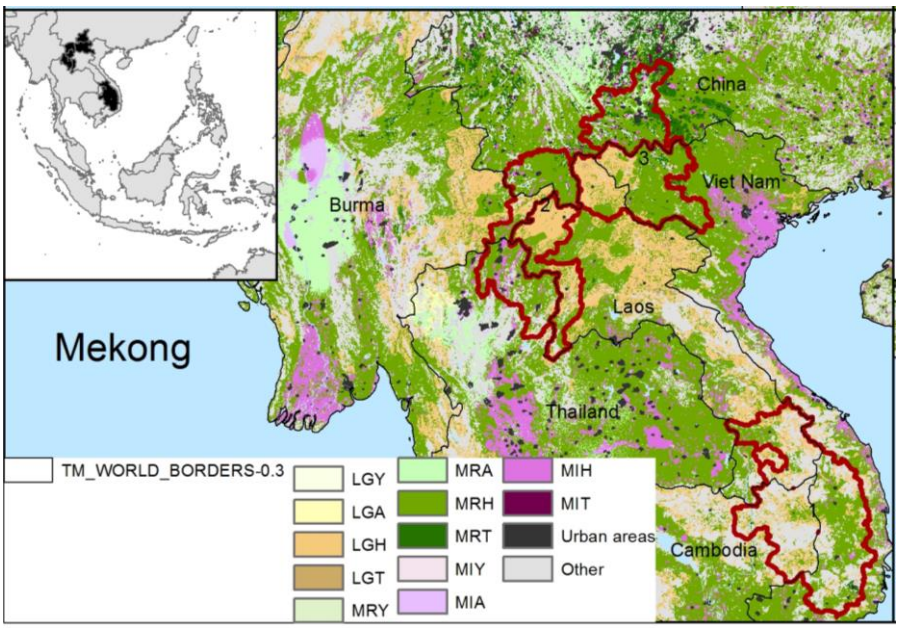

Figure 33 : Mekong action area and action site delineation visualized on the livestock system map

5.2 Similarity analysis for the green triangle

5.2.1 Euclidian similarity

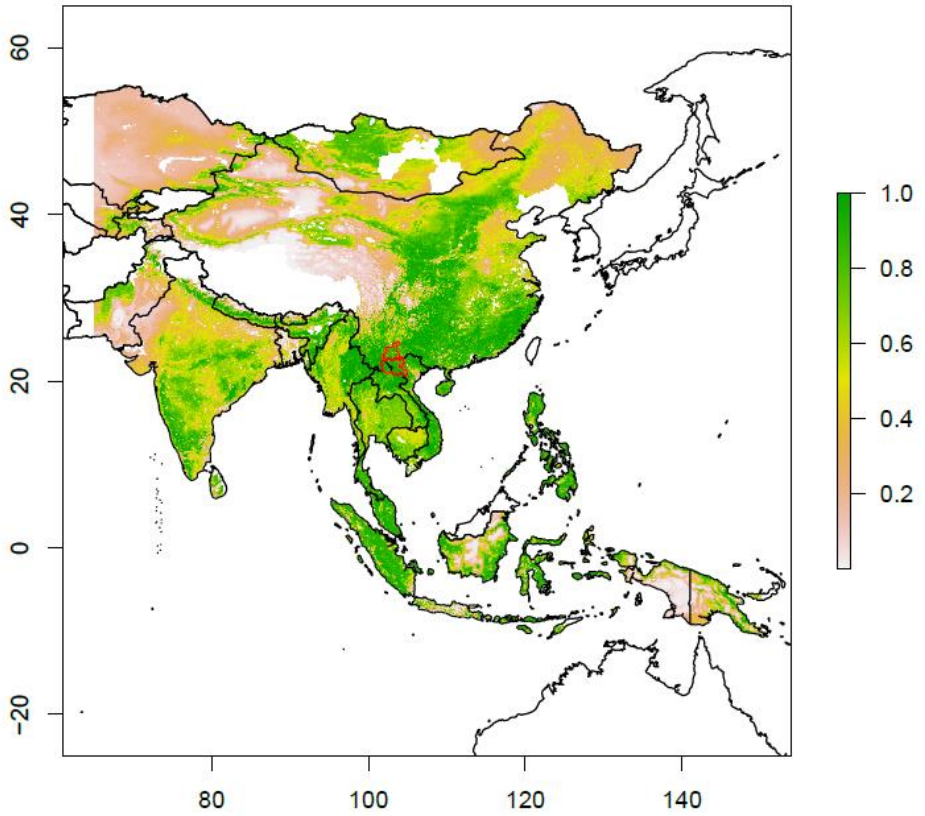

Figure 34 : Euclidian similarity for the green triangle

Figure 34 shows the Euclidian similarity for the green triangle. The green area suggests similar areas, which are mainly found in the East of China as well as in Malaysia and the Western Indonesian islands. Also parts of India seem to be similar, even the relatively dry areas in Central India.

5.2.2 Mahalanobis similarity

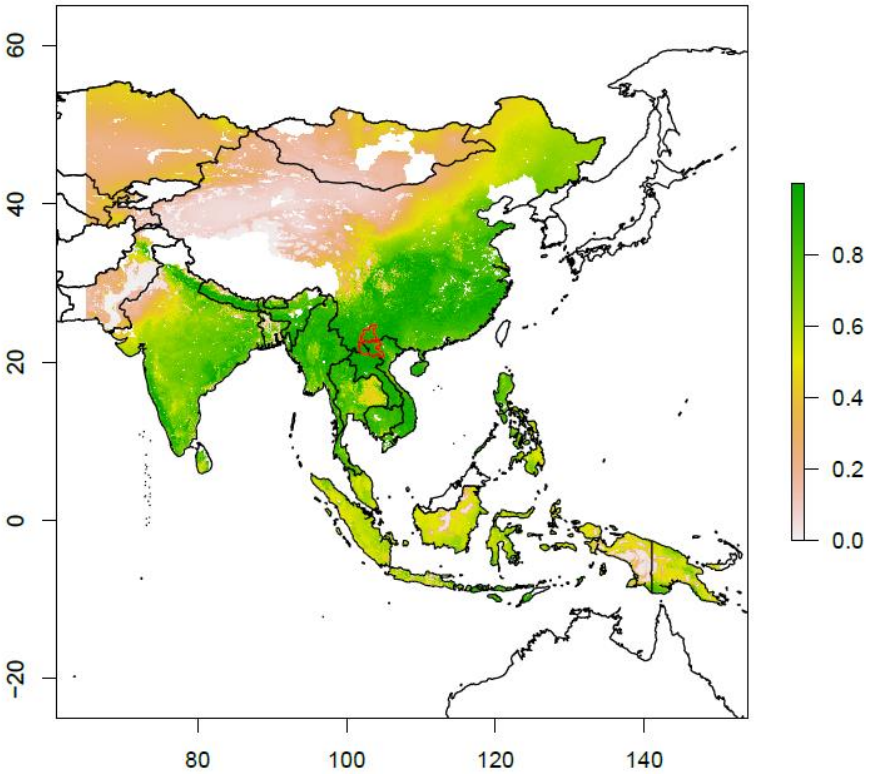

Figure 35 : Mahalanobis similarity for the green triangle

Figure 36 shows the Mahalanobis similarity for the green triangle. The greener the area, the more similar it is. The pattern observed is quite different from the Euclidian distance. Indeed, now the islands as well as the dry part of central India seem much less similar. However areas around the study area including the whole of Eastern China are similar.

These different results can explained with the high heterogeneity of the data, for which Mahalanobis similarity accounts for. Therefore, this measurement of similarity seems more appropriate in this context.

5.2.3 Multivariate Environmental Similarity Surfaces

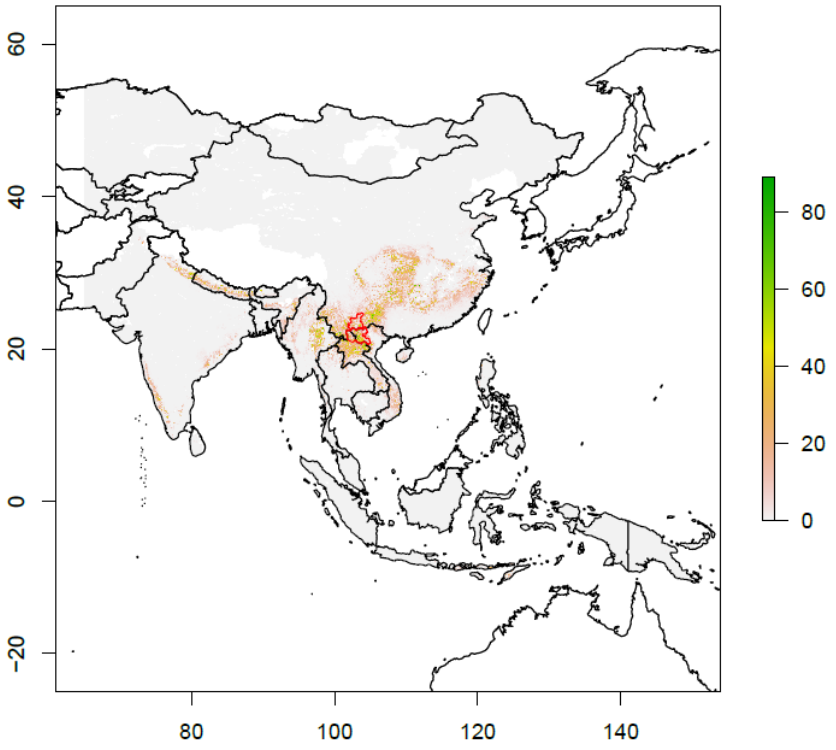

Figure 36 : Multivariate Environmental Similarity Surfaces for the green triangle

Figure 36 shows the Multivariate Environmental Similarity Surfaces for the green triangle. This measurement of similarity is the most restrictive one, and suggests that only area immediately around the study area, as well as part of Eastern China, South Nepal and the Costal area of India is similar.

5.2.4 Comparison

Table 12 shows the comparison of the Mekong sites with the green triangle. All the measurements suggest that the golden triangle is more similar to the green triangle. However, as the Multivariate Environmental Similarity Surfaces suggest, even the development triangle can still be considered as similar.

Table 12 : comparison of similarity for the Mekong Sites compared to the green triangle

	Euclidian	Mahalanobis	MESS positives only	MESS
Golden triangle	0.0363	6.91	13.31	12.85
Development triangle	0.0414	8.70	6.40	6.19

5.3 Similarity analysis for the golden triangle

5.3.1 Euclidian similarity

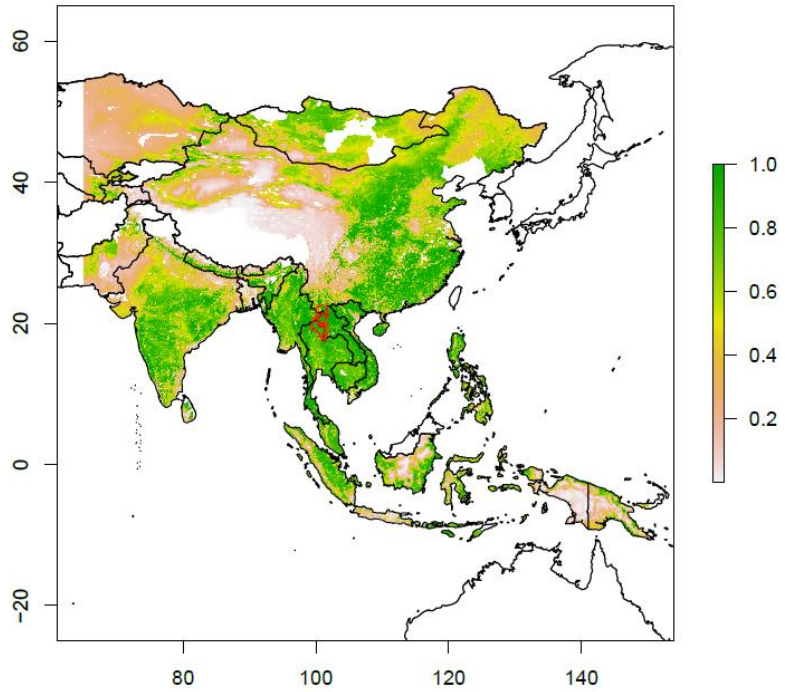

Figure 37 : Euclidian similarity for the golden triangle

Figure 37 shows the Euclidian similarity for the golden triangle. The green areas suggest similar areas, which are mainly found around the action site, in the East of China as well as in Malaysia and the Western Indonesian islands. Also parts of India seem to be similar, even the relatively dry areas in Central India.

5.3.2 Mahalanobis similarity

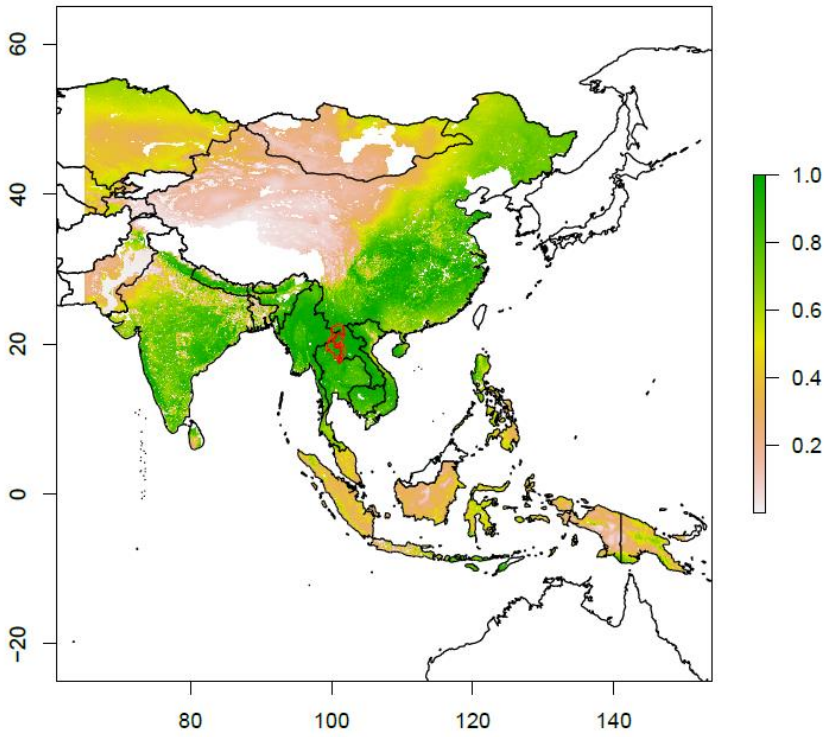

Figure 38 : Mahalanobis similarity for the golden triangle

Figure 38 shows the Mahalanobis similarity for the golden triangle. The greener the area, the more similar it is. Like for the green triangle, the pattern observed is quite different from the Euclidian distance. Indeed, now the islands as well as the dry part of central India seem much less similar.

However areas around the study area including the whole of Eastern China are similar. These different results can explained with the high heterogeneity of the data, for which Mahalanobis similarity accounts for. Therefore, this measurement of similarity seems more appropriate in this context.

5.3.3 Multivariate Environmental Similarity Surfaces

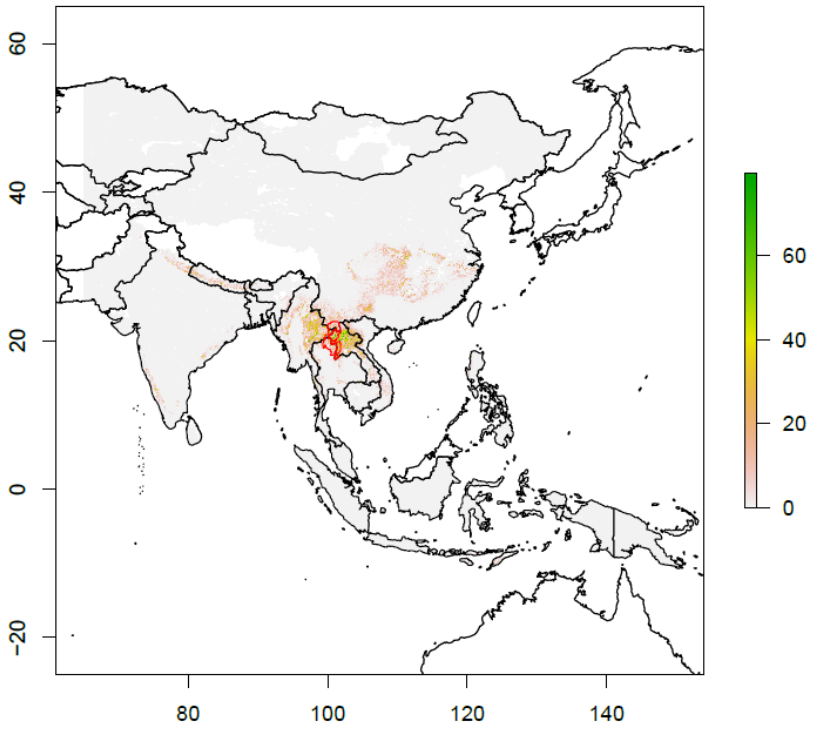

Figure 39 : Multivariate Environmental Similarity Surfaces for the development triangle

Figure 39 shows the Multivariate Environmental Similarity Surfaces for the golden triangle. This measurement of similarity is the most restrictive one. Like for the green triangle, it suggests that only area immediately around the study area, as well as part of Eastern China, South Nepal and the Costal area of India is similar.

5.3.4 Comparison

Table 13 shows the comparison of the Mekong sites with the golden triangle. All the measurements suggest that the green triangle is more similar to the golden triangle. Though Euclidian and Mahalanobis are almost equal as therefore suggesting similarity of the golden triangle with the development triangle, the Multivariate Environmental Similarity Surfaces suggest that these sites are not similar.

Table 13 : comparison of similarity for the Mekong Sites compared to the golden triangle

	Euclidian	Mahalanobis	MESS positives only	MESS
Green triangle	0.0381	25.78	7.11	3.80
Development triangle	0.0310	23.46	1.86	-4.43

5.4 Similarity analysis for the development triangle

5.4.1 Euclidian similarity

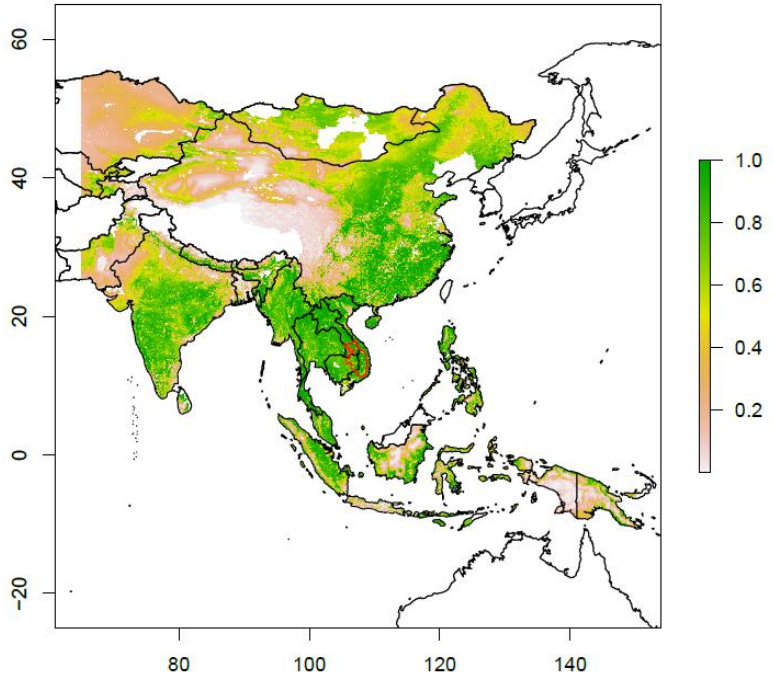

Figure 40 : Euclidian similarity for the development triangle

Figure 40 shows the Euclidian similarity for the development triangle. The green areas suggest similar areas, which are mainly found around the action site, in the East of China as well as in Malaysia and the Western Indonesian islands. Also parts of India seem to be similar, even the relatively dry areas in Central India.

5.4.2 Mahalanobis similarity

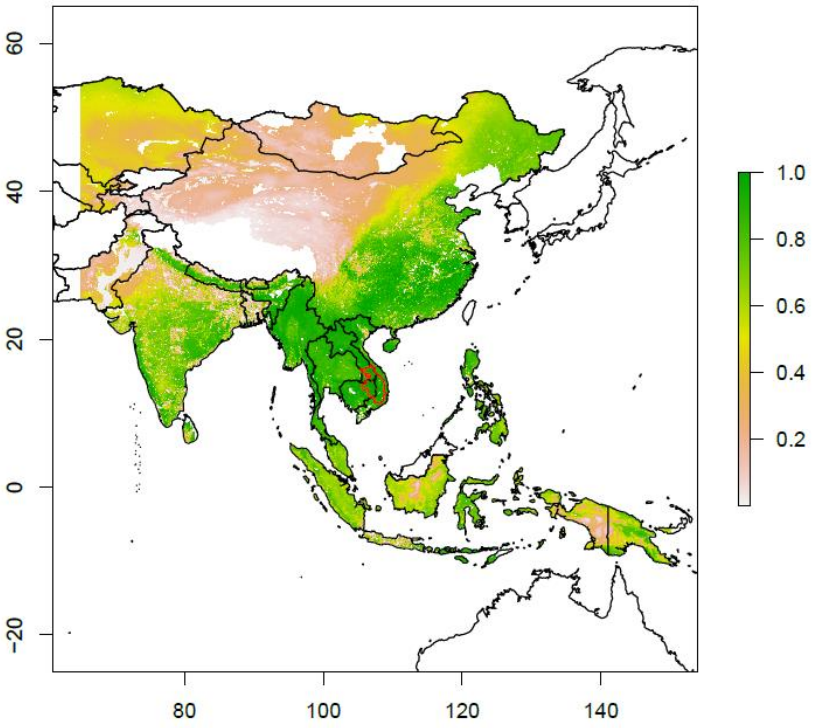

Figure 41 : Mahalanobis similarity for the development triangle

Figure 41 shows the Mahalanobis similarity for the development triangle. The greener the area, the more similar it is. Like for the green and golden triangle, the pattern observed is quite different from the Euclidian distance. Indeed, now the islands as well as the dry part of central India seem much less similar. However areas around the study area including the whole of Eastern China are similar. These different results can explained with the high heterogeneity of the data, for which Mahalanobis similarity accounts for. Therefore, this measurement of similarity seems more appropriate in this context.

5.4.3 Multivariate Environmental Similarity Surfaces

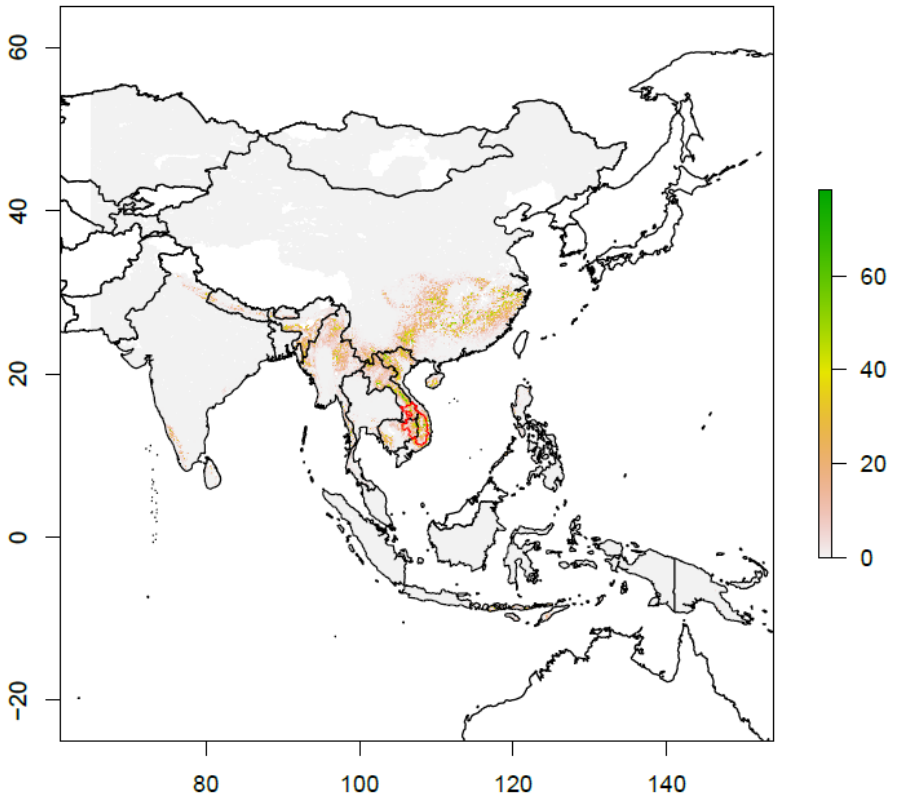

Figure 42 : Multivariate Environmental Similarity Surfaces for the development triangle

Figure 42 shows the Multivariate Environmental Similarity Surfaces for the development triangle. Again parts of China and parts of Burma, Vietnam and Laos are similar. Note that only few spot in the other triangle are similar.

5.4.4 Comparison

Table 14 shows the comparison of the Mekong sites with the development triangle. Whereas Euclidian and Mahalanobis similarity suggest that the golden triangle is the more similar to the the development triangle, the Multivariate Environmental Similarity Surfaces suggest that the green triangle is more similar.

Table 14 : comparison of similarity for the Mekong Sites compared to the development triangle

	Euclidian	Mahalanobis	MESS positives only	MESS
Green triangle	0.0398	31.50	12.38	10.69
Golden triangle	0.0244	13.07	7.34	6.75

Conclusion for Mekong action area

The green and the golden triangle are consistently similar and therefore will allow for cross-site learning, however the development triangle is mostly considered as different.

6 Analysis for Central America action sites

6.1 Site delineation of Central America action sites

The Central America action area consists of five action sites, namely in Guatemala, Honduras, El Salvador, Nicaragua, Haiti and Dominican republic as shown in Figure 43. For matter of similarity analysis, we have clustered Guatemala, Honduras and El Salvador into one action site, as well as Haiti and Dominican Republic another site. With Nicaragua, this results into 3 action sites for similarity analysis

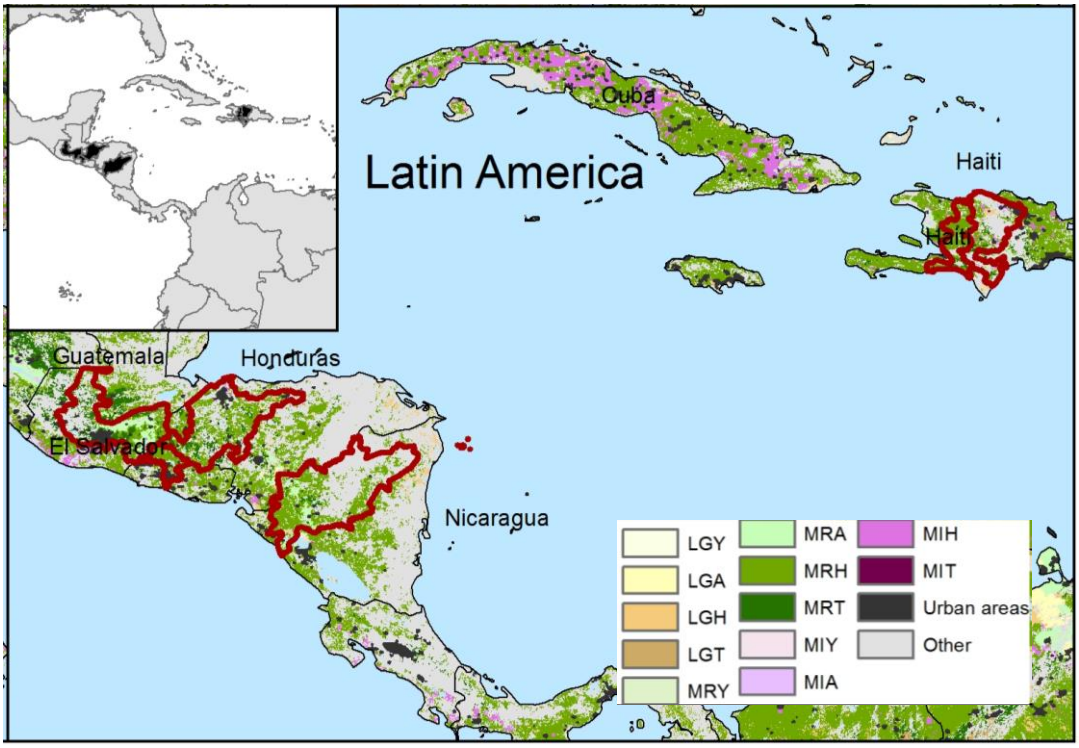

Figure 43 : Central America action area and action site delineation visualized on the livestock system map

6.2 Similarity analysis for Nicaragua

6.2.1 Euclidian similarity

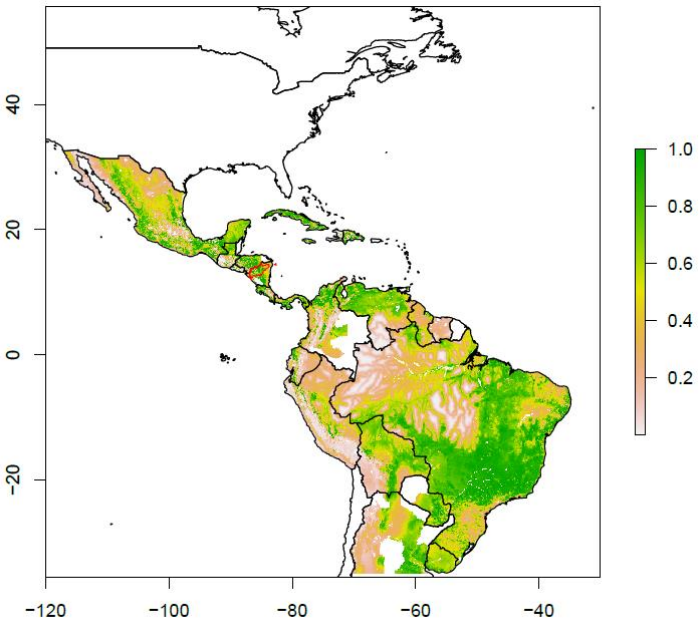

Figure 44 : Euclidian similarity for Nicaragua

Figure 44 shows the Euclidian similarity for Nicaragua. The green areas suggest similar areas, which are mainly found North of the action site, as well as the Island and big parts of East Brazil.

6.2.2 Mahalanobis similarity

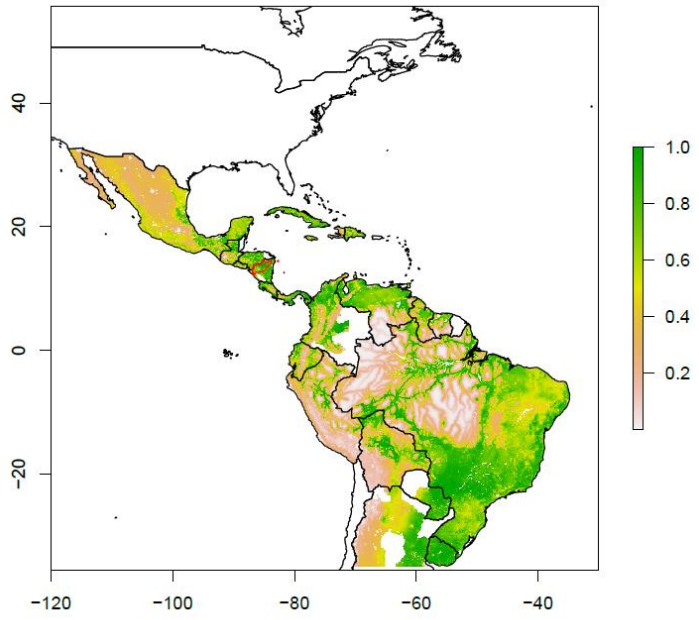

Figure 45 : Mahalanobis similarity for Nicaragua

Figure 45 shows the Mahalanobis similarity for Nicaragua. The greener the area, the more similar it is. The pattern is pretty similar to the Euclidian distance.

6.2.3 Multivariate Environmental Similarity Surfaces

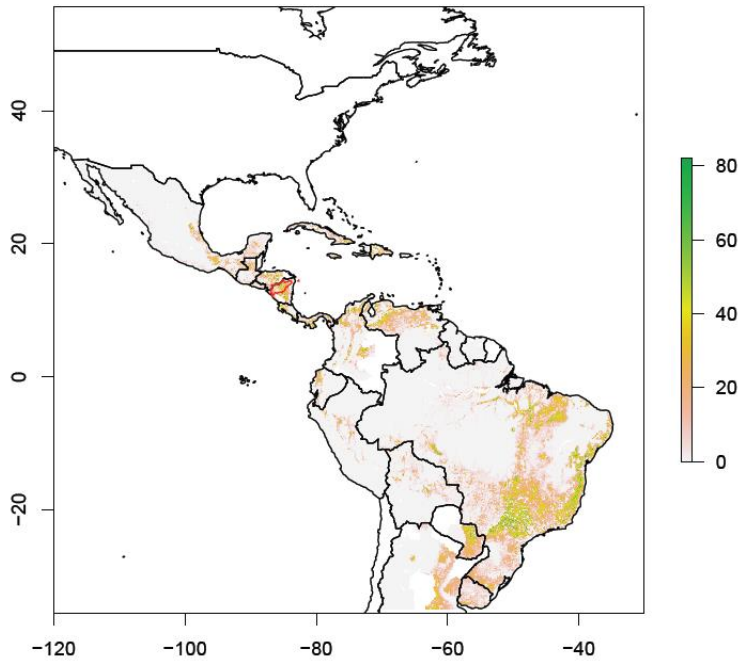

Figure 46 : Multivariate Environmental Similarity Surfaces for Nicaragua

Figure 46 shows the Multivariate Environmental Similarity Surfaces for Nicaragua. Again areas around the action site are similar, as well as the islands and South East of Brazil.

6.2.4 Comparison

Table 15 shows the comparison of the Nicaragua site with the other Central American sites. Whereas Euclidian suggest that all sites are quite similar, both Mahalanobis suggests only Haiti is similar. Finally MESS indicates that all the sites are quite different.

Table 15 : comparison of similarity for the Central American sites compared to Nicaragua

	Euclidian	Mahalanobis	MESS positives only	MESS
Haiti cluster	0.115	24.49	6.73	-5.35
Honduras cluster	0.0976	208.11	7.07	-4.98

6.3 Similarity analysis for Honduras, Guatemala, El Salvador cluster

6.3.1 Euclidian similarity

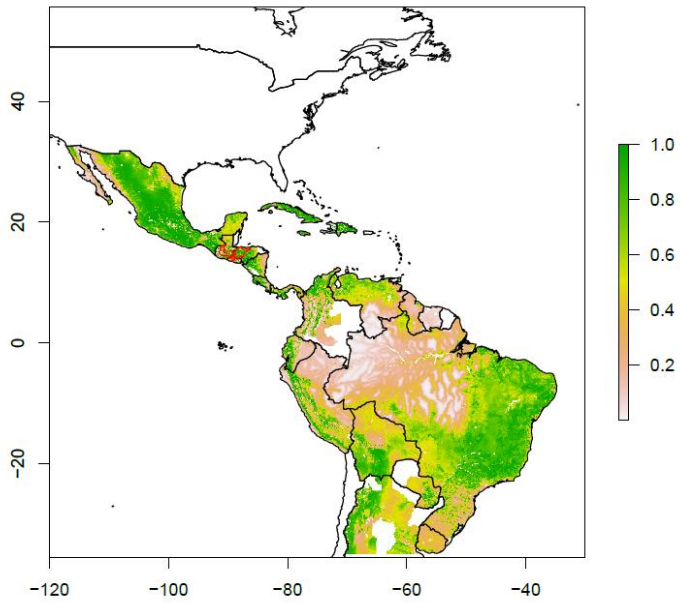

Figure 47 : Euclidian similarity for the Honduras, Guatemala, El Salvador cluster

Figure 47shows the Euclidian similarity for the Honduras, Guatemala and El Salvador cluster. The green areas suggest similar areas, which are mainly found north of the action site including major parts of Mexico, as well as the Island and big parts of East Brazil as well as the Western coastal zone of the South American continent.

6.3.2 Mahalanobis similarity

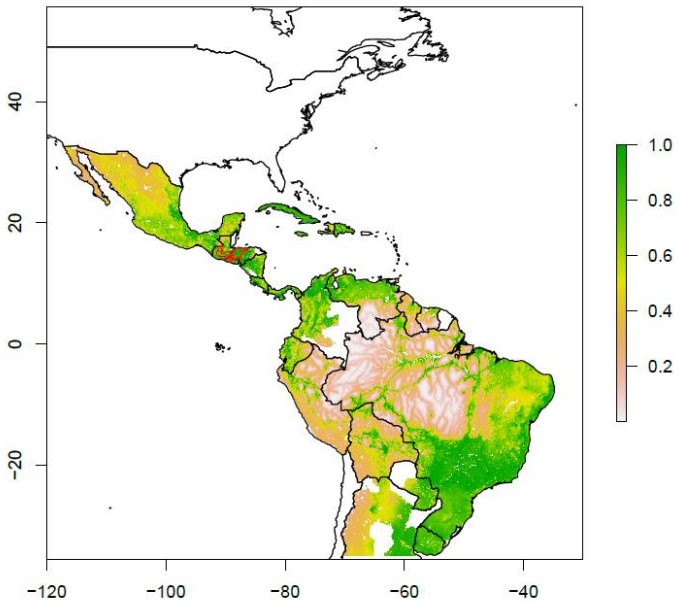

Figure 48 : Mahalanobis similarity for the Honduras, Guatemala, El Salvador cluster

Figure 48 shows the Mahalanobis similarity for the Honduras, Guatemala, El Salvador cluster. The greener the area, the more similar it is. The pattern is pretty similar to the Euclidian distance.

6.3.3 Multivariate Environmental Similarity Surfaces

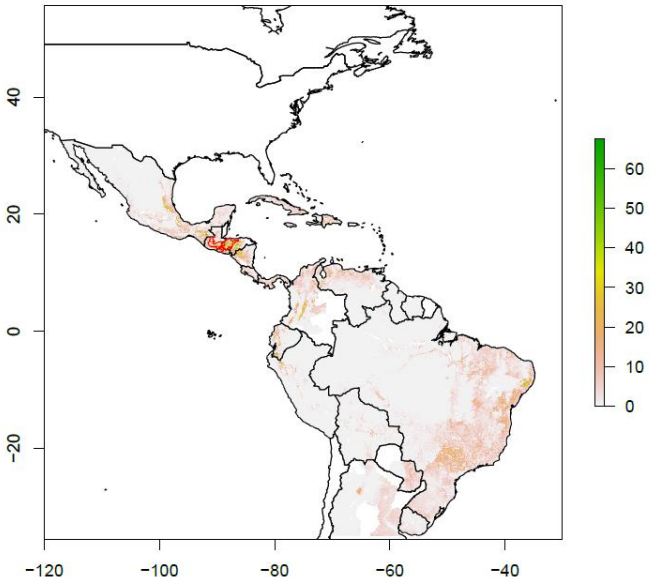

Figure 49 : Multivariate Environmental Similarity Surfaces for the Honduras, Guatemala, El Salvador cluster

Figure 49 shows the Multivariate Environmental Similarity Surfaces for the Honduras, Guatemala, El Salvador cluster. Again areas around the action site are similar, as well as the East of Brazil and to a certain extent the islands. Interestingly, the area around Mexico is considered as different with the method.

6.3.4 Comparison

Table 16 shows the comparison of the Hondurans, Guatemala and El Salvador cluster with the other Central American sites. Whereas both Euclidian and Mahalanobis suggest only a similarity to a certain extent, MESS suggest that only Nicaragua is similar.

Table 16 : comparison of similarity for the Central American sites compared to the Honduras, Guatemala, El Salvador cluster

	Euclidian	Mahalanobis	MESS positives only	MESS
Nicaragua	0.0866	9.25	9.69	9.35
Haiti cluster	0.1030	13.35	4.08	-1.59

6.4 Similarity analysis for Haiti cluster

6.4.1 Euclidian similarity

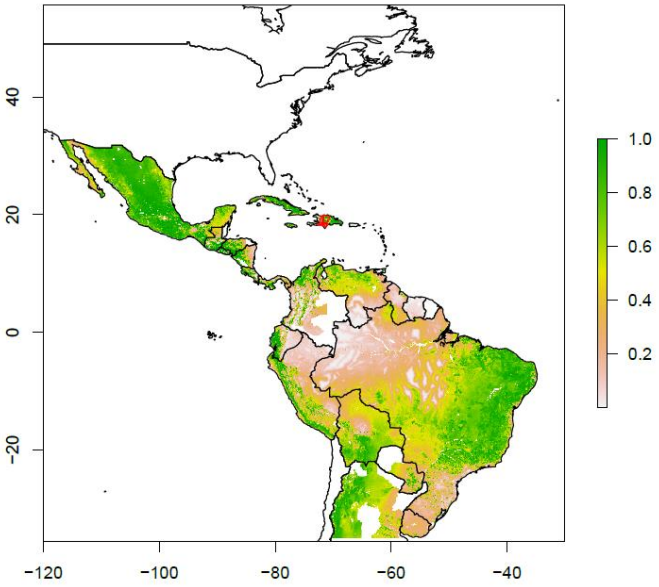

Figure 50 : Euclidian similarity for the Haiti cluster

Figure 50 shows the Euclidian similarity for Haiti cluster. The green areas suggest similar areas, which are mainly in Mexico, Eastern Brazil, North Argentina, South Bolivia and the coastal area of Peru. Note that parts of Nicaragua as well as the Honduras Guatemala El Salvador cluster are similar.

6.4.2 Mahalanobis similarity

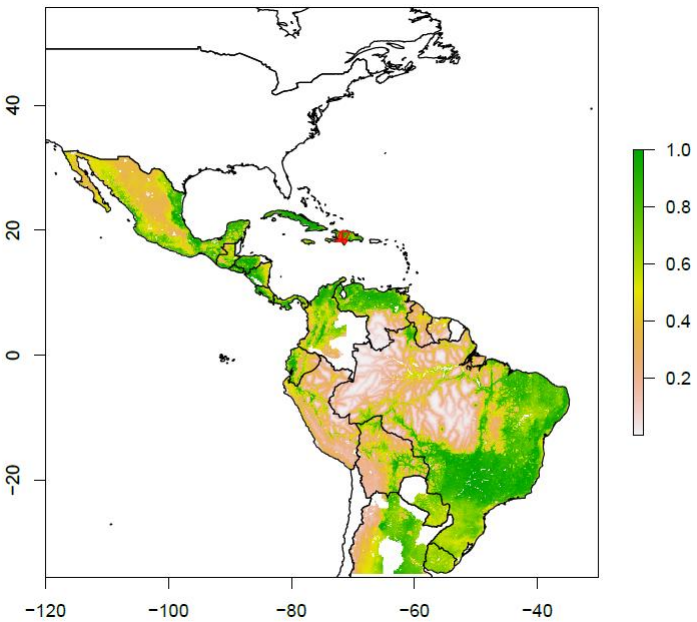

Figure 51 : Mahalanobis similarity for the Haiti cluster

Figure 51 shows the Mahalanobis similarity for the Haiti cluster. The greener the area, the more similar it is. The pattern is pretty similar to the Euclidian distance.

6.4.3 Multivariate Environmental Similarity Surfaces

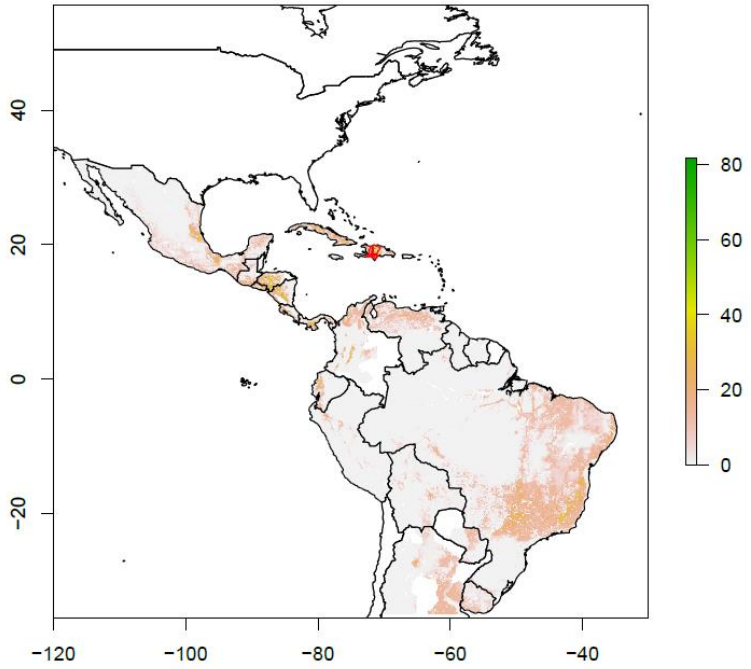

Figure 52 : Multivariate Environmental Similarity Surfaces for the Haiti cluster

Figure 52 shows the Multivariate Environmental Similarity Surfaces for Nicaragua. Again areas around the other sites are quite similar, as well as the islands and East of Brazil.

6.4.4 Comparison

Table 16 shows the comparison of the Haiti cluster. Euclidian and MESS suggest that all sites are quite similar.

Table 17 : comparison of similarity for the Central American sites compared to Haiti cluster

	Euclidian	Mahalanobis	MESS positives only	MESS
Nicaragua	0.102	16.67	11.90	10.41
Honduras cluster	0.098	39.88	12.39	10.11

6.5 Conclusion for Central American action area

The similarity measurement for the three sites do not give consistent results on which of the sites is similar to another. It is therefore very difficult to say anything about cross-site learning.

7 Discussion and conclusion

In most of the action areas, results from the different similarity methods yield at similar interpretation. The only area where this is not the case is the Mekong. For this action area different patterns of similarity can be observed for the different methods. High heterogeneity of the sites, can explain this phenomenon. Most commonly Euclidian similarity gives suggests the biggest suitable area and MESS the smallest. Also MESS is the most advanced method that compares distributions of variables rather than just using an average. It is therefore a better indicator for similarity.

All three methods use the action site as a reference point, this implies that any measurement is relative to this site. Therefore, it makes little sense to compare across the different runs. However, consistent and less consistent patterns can be identified, and therefore inform about the uncertainty of the similarity measurement. If across all runs actions are similar to each other, it is very likely that there a cross-site learning is possible. If two sites are only similar across a few runs and not at all in others, it is less likely that these sites are similar and therefore cross-site learning is probably less useful.

This report presents a similarity analysis of the general agricultural context of the Humidtropics action sites. It uses a generic definition of context to compare the different sites and understand the out-scaling potential. The data used are all globally available layers, allowing to run the same analysis for the other action areas of the Humidtropics.

However, in a later stage, more detailed data can be introduced that might be available only for some of the areas. A promising initiative is currently the extraction of subnational household data from the DHS dataset (MEASURE DHS, 2013), that will allow to extend amount socio-economic variables including some gender indicators.

Also, once best bet innovation and the context in which they are working are well identified, a similarity to context specific to an innovation can be run, defining the out-scaling potential for that particular best bet.

Finally the similarity analysis can also be applied to lower scale, and might in future assess out-scaling potential from field tested innovation at action field sites to other places in the action sites.

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