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ABSTRACT

In the present study, CDM host countries are classified according to their attractiveness for CDM non-sink projects. A cluster analysis is conducted based on three different factors determining host country attractiveness (mitigation potential, institutional CDM capacity and general investment climate) in order to elaborate a CDM host country classification. The results suggest that only a small proportion of potential host countries will attract most of the CDM investment. The CDM (non-sink) stars are China, India, Brazil, Argentina, Mexico, South Africa, Indonesia and Thailand. They are followed by attractive countries like Costa Rica, Trinidad and Tobago, Mongolia, Panama, and Chile. While most of the promising CDM host countries are located in Latin America and Asia, the general attractiveness of African host countries is relatively low (with the exception of South Africa). Policy implications of this rather inequitable geographical distribution of CDM project activities are discussed briefly.

Keywords: Clean development mechanism, Kyoto Protocol, attractiveness, cluster analysis

JEL-Classifications: Q25, C49

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Introduction

The Kyoto Protocol which sets legally binding emission reduction targets for the so-called Annex-I countries[1] (mainly industrialized countries and countries with economies in transition) includes the flexible mechanisms emissions trading, Joint Implementation (JI), and the Clean Development Mechanism (CDM). The latter allows Annex-I countries to use credits generated by emission reduction (or carbon sequestration) projects in developing countries for compliance. However, the CDM is not only supposed to assist countries with emission reduction commitments under the Kyoto Protocol in achieving their GHG targets, but also to contribute towards sustainable development in the host countries. Annex-I countries can provide financing for CDM projects either via equity investment (co-)financing the emission reduction project, via forward purchases or by buying the already produced "certified emission reduction" (CER) on the secondary market.[2] According to a recent decision of the Executive Board, CERs can also be created by unilateral CDM projects.[3] After the main rules governing the CDM were decided at the Seventh Session of the Conference of the Parties (COP 7) in 2001, a process of refinement of implementation modalities and the development of the necessary infrastructure for the complex CDM project cycle began. While the overall contribution of CDM in the compliance of Annex-I countries will depend on a variety of different factors outside the influence of host countries, the distribution of the CDM investment does and will depend mainly on the attractiveness of host countries for CDM.[4] Against the background of the Kyoto Protocol entering into force in February 2005, and the kick-off of the CDM market, the question arises how CDM investment flows will be distributed between the competing potential host countries. This is especially relevant, since Decision 17/CP.7 of the Marrakech Accords emphasizes the importance of an "equitable geographic distribution of clean development mechanism project activities at regional and sub regional levels" (UNFCCC 2001).

When looking for factors influencing the direction of CDM investment flows, the literature does not provide a satisfying answer. Often, one will find the simplistic assumption, that

[1] The term Annex-I country is often used to refer to the countries with emission targets under the Kyoto Protocol. This is, however, not exact. Annex I refers to the UNFCCC. Parties with emission reduction targets are listed in Annex B of the Kyoto Protocol, therefore labeled Annex-B countries. Only two countries (Turkey and Belarus) are Annex-I countries, but are not listed in Annex B.

[2] See also Arquit Niederberger and Saner (2005)

[3] For a detailed study on unilateral CDM , see Jahn et al. (2004)

[4] This is true for almost all of the forms of CDM investment, however, not for the unilateral CDM. While forward purchase agreements allow buyers to reduce the risks involved in a concrete CDM project, the risk of CER accrual remains. Here country risks play an important role.

CDM flows will mainly follow the pattern of foreign direct investment (FDI) flows. Arquit Niederberger and Saner (2005) criticize this assumption and clarify CDM-related determinants of FDI flows. Fankhauser and Lavric (2003) study the attractiveness of JI host countries, and identify three factors determining the attractiveness of a JI host country:

- the scope for cheap emission reductions,
- the institutional capacity of a host country to process JI deals, and
- the general investment climate.

These factors apply to CDM[5] investment as well as for JI and are used in the following as a basis for defining the attractiveness of CDM host countries for non-sink projects.[6]

While the simplistic assumption that CDM follows FDI flows only considers the last of these three factors, I use the explorative tool of cluster analysis to classify CDM host countries by using information on all three factors. Cluster analysis is a multivariate statistical procedure that identifies relatively homogenous groups of elements in a given data set. It has to be emphasized, though, that cluster analysis is an explorative tool, based on different plausible algorithms.[7] It is therefore useful for developing a first classification or investigating a conceptual scheme for grouping elements, which can help to improve the understanding of the respective issue (Aldenderfer and Blashfeld 1984, Bacher 2002, Mucha 1992).

The host country classification based on their attractiveness for CDM non-sink projects provides a first picture of what the distribution of CDM flows might look like in a mature CDM market. While the present study is concerned with a more general picture, host country ratings (for example the one by Point Carbon[8]) are much more detailed, but focussed on a smaller set of countries. Therefore, both can be seen as complementary approaches in explaining CDM host country attractiveness.

Indicators for host country attractiveness

For using the three factors emission reduction potential, institutional CDM capacity and general investment climate in the cluster analysis, appropriate indicators have to be identified. 114 host countries for which the respective data was available are included in the analysis.

[5] A survey conducted by Point Carbon (2002) identifies a supportive CDM approval system as well as the investment climate as the most important factors influencing CDM investment.

[6] We are limiting our analysis to non-sink projects, since the CDM forestry potential is quite different from the emission reduction potential in the non-sink sector. Furthermore, data on potentials for CDM forestry projects is subject to rather high uncertainties.

[7] The software package CLUSTAN is used for the analysis.

[8] For details see: http://www.pointcarbon.com/category.php?categoryID=723

The indicators used in this analysis are summarized in Table 1 below. While Fankhauser and Lavric (2003) use expected carbon emissions per GDP as a measure of a countries´ emission reduction potential, I argue that the expected absolute greenhouse gas emissions (GHG) are a better indicator. First, the absolute value of emissions is more appropriate because the indicator emission intensity (e.g. CO_2 emissions/GDP) is not comparable due to its complex formation and the different factors influencing the level of this indicator (Sun 2000). Secondly, only focussing on CO_2 is not sufficient to reflect the wide range of greenhouse gas emission reduction options eligible under the CDM; currently most of the CDM projects actually reduce non-CO_2 gases.[9] Thus, data on GHG emissions in 2001, taken from the Climate Analysis Indicators Tool - CAIT - (WRI 2003) serve as an indicator for emission reduction potential in CDM host countries.

Until emission reduction credits can be generated by a CDM project, projects have to pass a relatively complex project cycle. As prerequisites for a CDM project to be submitted to the Executive Board, the country has to have ratified the Kyoto Protocol and is obliged to have a Designated National Authority (DNA) operating. The latter has to approve the CDM project activity and confirm that it is complying with the national definition of sustainability. For setting-up a well-functioning and efficient DNA, there is a need for expert knowledge inside the government on rules and modalities governing the CDM.[10] It can be assumed that those countries which participated in the AIJ pilot phase (Activities Implemented Jointly), and completed a National Strategy Study analyzing their CDM potential will be able to profit from the experiences and knowledge gained. Therefore, the indicators ratification of the Kyoto Protocol[11], participation in the AIJ pilot phase, timely establishment of a Designed National Authority (DNA)[12] as well as completion of a National Strategy Study (NSS)[13] form an index representing the institutional CDM capacity of a CDM host country[14].

As an indicator for the general investment climate, I create an index based on the World Governance Research Indicators Dataset[15] (World Bank 2004), using the dimensions of political stability, regulatory quality and rule of law.[16]

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[9] Of the projects available for validation comments on the UNFCCC CDM website by Feb. 10 2005, 84% of estimated CERs come from non-CO_2 gases.

[10] Michaelowa (2003) deals with the tasks of host countries in the CDM project cycle, and highlights the importance of effective host country institutions for reaping benefits from the CDM market. Willems (2004) deals with the role of the institutional capacity in selecting climate actions in general.

[11] As of 5 October 2004 (www.unfccc.int)

[12] Defined as DNA operating by 4 November 2004.

[13] As of November 2004.

[14] Countries for which none of these criteria apply, will therefore have a minimum value of zero, the ones for which all of them apply a maximum value of 4.

[15] For details on the Governance Indicators see Kaufmann et al. (1999a), Kaufmann et al. (1999b), Kaufmann et al. (2003) as well as the website at: http://www.worldbank.org/wbi/governance/govdata2002/index.html.

Dimension	Variable
Emission reduction potential (in the non-sink sector)	Expected GHG emissions in 2010 (Gg CO_2)
Institutional CDM capacity	Index (0-4) based on: - Kyoto ratification, - AIJ experience, - CDM authority (DNA) installed timely, - National Strategy Study (NSS) completed
General investment climate	Index based on averages (1994-2003) of three dimensions of World Bank World Governance Research Indicators Dataset

Table 1: Indicators of host country attractiveness for non-sink CDM projects

The data exploration shows that those host countries with higher GHG emissions tend to have built up a better institutional CDM capacity. While there is no significant relation of the mitigation potential of a country to its investment climate, an improvement in the latter seems to be favoring a better institutional CDM capacity, though. However, none of the correlations is very strong.[17]

Classification of host countries by cluster analysis

As the data used in this analysis is measured on different scales, it is standardized, using z-scores. In the first step of the analysis, I use the Single-linkage algorithm[18] to identify outliers. China, India and Brazil are identified as such, and are excluded from the data set. In a second step, the Ward-algorithm[19], which minimizes the variance within the clusters, is applied. The variance is defined as:

$$V_g = \sum_{k=1}^{K_g} \sum_{j=1}^{J} (x_{kjg} - \overline{x}_{jg})^2$$

Kearney (2004) conducted a survey on the most critical risks to firm operation. Government regulation/legal decisions, country financial risk as well political and social disturbances are below the most important risks mentioned by more than 60% of total respondents.

[16] The range of the indicator is from -7.5 to 7.5, with higher values indicating a better investment climate.

[17]Pearson correlation coefficient of 0.29 and 0.31, respectively.

[18] The Single-linkage algorithm is the simplest of all algorithms and is able to identify outlier well by joining them in the last clustering step(s).

[19] The Ward-algorithm is sometimes also labelled „Increase in sum of squares“, “Within-group sum of squares” or “Error sum of squares”. It requires a proximity matrix of squared euclidian distances.

where x_{kjg} is the value of the variable j for object k for all objects k in group g, and $\bar{x}_{jg}$ is the average of the values of variable j in group g. The Ward method joins those groups or elements that result in the smallest increase of V_g.

Cluster	Ward	k-means
Cluster 1	Albania, Suriname, Central African Rep., Ivory Coast, Mozambique, Gabon, Macedonia, Sao Tome and Principe, Bosnia and Herzeg., Chad, Guinea-Bissau, Ethiopia, Kenya, Benin, Lesotho, Seychelles, Dominican Rep., Ghana, Gambia, Guyana, Malawi, Lebanon, Mauritania, Zambia, Burkina Faso, Senegal, Kyrgyzstan, Nepal, Syrian Arab Rep., Tanzania, Cameroon, Guinea, Papua New Guinea, Togo, Rwanda	Albania, Suriname, Central African Rep., Ivory Coast, Mozambique, Gabon, Macedonia, Sao Tome and Principe, Bosnia and Herzeg., Chad, , Ethiopia, Kenya, Benin, Lesotho, Seychelles, Dominican Rep., Ghana, Gambia, Guyana, Malawi, Lebanon, Mauritania, Zambia, Burkina Faso, Senegal, Kyrgyzstan, Nepal, Syrian Arab Rep., Tanzania, Cameroon, Guinea, Papua New Guinea, Togo, Rwanda
Cluster 2	Bahamas, Botswana, Qatar, Tunisia, Bahrain, Cape Verde, Kuwait, Brunei Darussalam, Oman, United Arab Emirates	Bahamas, Botswana, Qatar, Tunisia, Bahrain, Cape Verde, Kuwait, Brunei Darussalam, Oman, United Arab Emirates
Cluster 3	Algeria, Sudan, Turkmenistan, Congo, Sierra Leone, Haiti, Libyan Arab Yam., Tajikistan, Dem. Rep. Congo (Zaire), Iraq, Liberia	Guinea-Bissau, Algeria, Sudan, Turkmenistan, Congo, Sierra Leone, Haiti, Libyan Arab Yam., Tajikistan, Dem. Rep. Congo (Zaire), Iraq, Liberia
Cluster 4	Antigua and Barbuda, Belize, Mongolia, Maldives, Trinidad and Tobago, Chile, Costa Rica, Mauritius, Uruguay, El Salvador, Jordan, Panama	Antigua and Barbuda, Belize, Mongolia, Maldives, Trinidad and Tobago, Chile, Costa Rica, Mauritius, Uruguay, El Salvador, Jordan, Panama, Malaysia, Bolivia, Morocco
Cluster 5	Armenia, Moldova, Guatemala, Madagascar, Jamaica, Azerbaijan, Cuba, Laos, Niger, Paraguay, Uganda, Equatorial Guinea, Georgia, Yemen, Zimbabwe, Bangladesh, Israel, Philippines, Kazakhstan, Malaysia, Colombia, Egypt, Bolivia, Vietnam, Ecuador, Honduras, Nicaragua, Sri Lanka, Mali, Morocco, Peru	Armenia, Moldova, Guatemala, Madagascar, Jamaica, Azerbaijan, Cuba, Laos, Niger, Paraguay, Uganda, Equatorial Guinea, Georgia, Yemen, Zimbabwe, Bangladesh, Israel, Philippines, Colombia, Egypt, Vietnam, Ecuador, Honduras, Nicaragua, Sri Lanka, Mali, Peru
Cluster 6	Argentina, Thailand, Indonesia, Mexico, South Africa	Argentina, Thailand, Indonesia, Mexico, South Africa
Cluster 7	North Korea, Venezuela, Nigeria, Uzbekistan, Pakistan, Iran, Saudi Arabia	Kazakhstan, North Korea, Venezuela, Nigeria, Uzbekistan, Pakistan, Iran, Saudi Arabia

Table 2: Cluster membership of host countries

Ward is chosen, because it is considered to result in a very good cluster structure, if the expected clusters are relatively equivalent in size, and outliers are excluded from the data (Backhaus et al. 2003).

By applying a bootstrapping method, in a third step, it will be checked which tree partitions are significantly different from random.[20] The 7 and 8 cluster solution are the only ones

[20] This is a standard procedure included in CLUSTAN. For details see Wishart (2004).

deviating significantly from randomness. The 7 cluster solution of the Ward method[21] is used as the starting partition for a cluster analysis using the k-means method.[22] Contrary to hierarchical clustering methods as Ward, k-means belongs to the partitioning cluster methods which sort the cases in a series of iterations until converging to a stable partition of k clusters. The comparison of cases in the k-means method is based on the squared euclidian distance of the case to the cluster centers. If a case is found to be nearer to a cluster it is not part of, it will be moved to this cluster, until all the cases are in their nearest cluster. As k-means is able to identify very good cluster structure if a good starting partition and the cluster number are known, it can be used to "calibrate" the results of the Ward method.

Table 2 summarizes the cluster memberships of host countries for the Ward and the k-means method. Host countries which were moved to other clusters by the k-means method are underlined.

The last step of the cluster analysis is the most challenging one, namely the interpretation of the clusters found. In the following, I will only look at the results obtained by the k-means method. Analyzing cluster centers, shown in Table 3, gives a first impression of the main characteristics of each group.

	CDM capacity	**Mitigation potential**	**Investment climate**	**Exemplar**
Cluster 1	-0,650	-0,452	-0,128	Senegal
Cluster 2	-0,856	-0,319	1,494	Bahrain
Cluster 3	-0,982	-0,216	-1,749	Libyan Arab.Yam.
Cluster 4	1,096	-0,314	1,202	Panama
Cluster 5	0,823	-0,159	-0,203	Cuba
Cluster 6	1,654	3,169	0,421	South Africa
Cluster 7	-0,564	1,789	-0,533	Venezuela

Table 3: Cluster means (k-means) and exemplars

As the data was standardized for the cluster analysis, the mean over all countries is zero. Therefore, negative values show that a variable in the respective cluster has a significant lower mean than in the total population and vice versa. Now, each cluster can be broadly described in a qualitative manner, as done in Table 4, with the first term indicating a groups characteristic as compared to the mean of all the countries in the data set (based on Table 3), and the term in brackets expressing the absolute range given in each cluster. The ranges

[21] The 7 cluster solution is selected because it is characterized by a clear increase in the fusion coefficient which can be illustrated by an "elbow" in the inverse scree plot.
[22] For more details, see Bacher (2002), Mucha (1992), Aldenderfer and Blashfield (1984)

included in Table 4 show that there can be a considerable variance in each cluster, which is important regarding the homogeneity of the clusters obtained. For the interpretation of the clusters, not only the mean, but also the variance will have to be taken into account.

	CDM capacity		Mitigation potential		Investment climate	
	Mean compared to average	Range in cluster	Mean compared to average	Range in cluster	Mean compared to average	Range in cluster
Cluster 1	Low	No - low	Low	Very low - low	Bad	Very bad - bad
Cluster 2	Low	No - low	Low	Very low - low	Very good	Good - very good
Cluster 3	Low	No - low	Low	Very low - low	Extremely bad	Extremely bad
Cluster 4	High	Medium - very high	Low	Very low - high	Very good	Good - very good
Cluster 5	High	Medium - very high	Low	Very low - high	Bad	Very bad - medium
Cluster 6	Very high	High - very high	Extremely high	Very high– extremely high	Good	Very bad – good
Cluster 7	Low	No – medium	Very high	High – extremely high	Bad	Very bad - good

Table 4: Cluster characteristics

In order to test the homogeneity of the clusters, F-values are calculated for each variable and each cluster based on the following formula:

$$F = \frac{V(J,G)}{V(J)}$$

with V(J,G) representing the variance of variable J in group g, and V(J) the variance of variable J over all cases.

	CDM capacity	Mitigation potential	Investment climate
Cluster 1	0.16456583	0.0317284	0.17425392
Cluster 2	0.18697479	0.10517629	0.13606474
Cluster 3	0.14355742	0.17311233	0.42185129
Cluster 4	0.34663866	0.17472665	0.24127466
Cluster 5	0.22969188	0.23779605	0.17298938
Cluster 6	0.21008403	1.21960878	0.41401113
Cluster 7	0.55042017	0.87168136	0.47824987

Table 5: F-values for each cluster and variable

Values smaller than 1 indicate that the cluster can be considered as homogenous (Backhaus et al. 2003). Table 5, which includes the respective F-values, shows that only in cluster 6, there is a doubt about cluster homogeneity regarding the mitigation potential.

In the following, I will analyze and interpret each cluster separately with the aim to classify countries regarding their attractiveness for future CDM non-sink investment.

Cluster 1 is characterized by rather low institutional CDM capacity, low mitigation potential and a relatively bad investment climate. Consequently, it is to be expected that the countries in cluster 1 will not be able to attract any significant CDM (non-sink)[23] investment flows. Therefore, this group can be labelled as *very unattractive for (non-sink) CDM*. The majority of the countries belonging to this group are located in Africa (e.g. Mauritania, Ivory Coast, Ethiopia, Kenya, Tanzania). Some Eastern European countries (e.g. Albania, Macedonia), as well as Syria, Nepal, Papua New Guinea and Kyrgyzstan are part of this group as well. Cluster 2 includes those countries which are characterized by low institutional CDM capacity and mitigation potential, and which – contrary to cluster 1 – have a very good investment climate. Of the 10 countries in this group, half belongs to the Arabian oil exporting countries (e.g. Bahrain, Kuwait, Qatar, United Arab Emirates), while the others are spread over the whole globe (Bahamas, Tunisia, Botswana, Cape Verde, Brunei). In spite of their good investment climate, these countries can also be considered rather insignificant CDM host countries, since no climate project related conditions are given. As OPEC is not supporting the international climate regime in general, and those countries having a rather high mitigation potential (as compared to the other countries in the group) are the OPEC member states[24], these countries will not play any role in the CDM at all. This however may change if OPEC countries realize that significant revenues can be generated through CDM projects; a first indication is the rapid ratification of the Kyoto Protocol by a number of OPEC countries after Russian ratification ensured its entry into force. From the above, it can be concluded that cluster 2 will as well join the coalition of host countries which are *very unattractive for (non-sink) CDM* investments, but that some of these countries may move into Cluster 4 in the near future.

The 12 countries forming Cluster 3 are characterized by a low institutional CDM capacity, low mitigation potential, and an extremely bad investment climate. This group comprises countries of Northern, Western and Central Africa (e.g. Algeria, Liberia, Congo, Sudan) as

[23] Countries with bad investment climate and a low institutional CDM capacity will probably attract as little investment in LULUCF as in non-sink projects, since these two criteria will count for the investment in LULUCF projects as well.

[24] United Arab Emirates, Kuwait and Qatar

well as countries like Haiti, Tajikistan and Turkmenistan. There are few chances that any of the countries in this group will play a significant role in the CDM market, although, some of the countries would offer some mitigation potential (e.g. Algeria, Iraq). Therefore, countries in cluster 3 can be considered to belong to the *very unattractive (non-sink) CDM* host countries as well.

Cluster 4 includes countries with a medium to very high CDM capacity, and a (very) good general investment climate. However, the majority of the countries have a rather small mitigation potential, although the cluster includes as well some few countries which are characterized by high GHG emissions (Chile, Malaysia and Morocco). The small mitigation potential of most of the countries in this cluster can be explained by the fact that most of them are very small (e.g. Belize, Antigua and Barbuda, Uruguay, Panama, Costa Rica, Trinidad and Tobago, Jordan, Mauritius, Maldives). In general, host countries in cluster 4 can be rated as "attractive for CDM" (non-sink) investors, without being able to provide a big portion of CDM credits in the world-wide market, though.

Cluster 5 is very similar to cluster 4 regarding institutional CDM capacity and mitigation potential, with the difference that most of the host countries in this group offer a worse investment climate than countries in cluster 4. Egypt is an exception, and cannot be clearly distinguished from cluster 4. Members of this group are located in Latin America (e.g. Colombia, Guatemala, Ecuador, Peru, Nicaragua, Paraguay), in Africa (e.g. Mali, Niger, Uganda), and South East Asia (Laos, Philippines, Vietnam). Furthermore, countries like Yemen, Jamaica, Israel, Armenia, Azerbaijan, and Georgia are part of cluster 5 as well. Only a *limited attractiveness for non-sink CDM projects* can be assigned to this group, although some individual countries might offer a greater potential than others, with for example Vietnam and Egypt appear to be the most promising CDM (non-sinks) countries in this group.

The relatively small cluster 6 comprises the 5 countries Argentina, Indonesia, Mexico, South Africa, and Thailand. Based on the cluster means, these countries are CDM-frontrunners, with extremely high CDM capacity, exceptionally high mitigation potential and a good investment climate. When looking at the data for each country, the doubt about the homogeneity of the cluster regarding the mitigation potential can be ruled out. The exceptionally high values for Indonesia, Mexico and South Africa as compared to can explain the problematic F-value. The values, however, allow a consistent interpretation of the cluster regarding the mitigation potential. Nevertheless, the data shows a rather big range of values for the investment climate, where Indonesia is clearly identified as a negative outlier in the group. The countries in this group can be described as *very promising CDM (non-sink) countries,* keeping in mind, though, that Indonesia's attractiveness might be hampered to some extent by its relatively bad investment climate.

The common feature of host countries in cluster 7 is mainly their extremely high mitigation potential, while values for the institutional CDM capacity and the investment climate vary considerably. Although investors might find a considerable potential for CDM (non-sink) projects in these countries, they will probably be deterred either by a very bad investment climate or a very low CDM capacity. Due to the latter, host countries in cluster 7 are considered *unattractive for CDM (non-sink) projects*.

Last but not least, the three countries (China, India, and Brazil) which had been excluded from the data set as outliers are mentioned as well. These three countries are characterized by a huge mitigation potential, a good institutional CDM capacity and a good investment climate, and are known to be the *most promising CDM (non-sink) host countries*.

Resulting from the above, four main groups of host countries for CDM non-sink projects can be identified: countries which are very unattractive, countries which are attractive to a limited extent, attractive countries, as well as very attractive countries. The attractiveness of CDM host countries as represented by the respective clusters is summarized in Table 6.

	Very unattractive	**Attractive to a limited extent**	**Attractive**	**Very attractive**
Clusters	Cluster 1 Cluster 2 Cluster 3 Cluster 7	Cluster 5	Cluster 4	Cluster 6, China, India, Brazil

Table 6: Clusters regarding their attractiveness as CDM (non-sink) host countries

In the interpretation of clusters, I already mentioned the case of Egypt which would fit as well to cluster 4, but has been included to cluster 5 by the cluster analysis. In real world data, there always exist unstable cases which cannot be clearly attributed to one group. It is therefore an essential part of the interpretation of the cluster analysis to point out which of the elements are not clearly attributable to one cluster only. Table 7 shows the cases which are very similar to another cluster[25], and denotes if this 'instability' does have consequences for the above host country attractiveness classification (as illustrated in Table 6). 19 cases could be identified as

[25] Defined as the distance to its nearest cluster being smaller 0.25 than the distance to any of the other clusters.

also being very close to the mean of another cluster. The countries Benin, Lesotho and Seychelles, and Cape Verde appear to lie somewhere between cluster 1 and cluster 2. As both clusters include very unattractive CDM host countries, this instability does, however, not change our host country classification.

Country	Member of cluster	Not clearly distinguished from cluster	Affects classification of attractiveness
Benin	1	2	No
Bolivia	4	5	Yes
Bosnia and Herzeg.	1	3	No
Cape Verde	2	1	No
Chad	1	3	No
Egypt	5	4	Yes
Guinea-Bissau	3	1	No
Israel	5	4	Yes
Jamaica	5	4	Yes
Kazakhstan	7	1	No
Kenya	1	3	No
Lesotho	1	2	No
Morocco	4	5	Yes
Philippines	5	4	Yes
Rwanda	1	3	No
Seychelles	1	2	No
Turkmenistan	3	1	No
Uzbekistan	7	5	Yes
Vietnam	5	4	Yes

Table 7: Countries not clearly attributable to one cluster and effect on classification of attractiveness for CDM

The latter applies as well to the border cases between cluster 1 and 3 (Bosnia and Herzegovina, Chad, Guinea-Bissau, Kenya, Rwanda, and Turkmenistan) and cluster 7 and 1 (Kazakhstan). Nevertheless, in some of the cases host country attractiveness might be estimated wrongly if only relying on the cluster membership as given by the k-means method. As already noted above, ranges in cluster 4 and 5 are relatively big, which hinders the interpretation of the CDM attractiveness of host countries in these clusters. The 7 countries that could belong as much to cluster 4 as to cluster 5 are either the lesser attractive cases of cluster 4 (Bolivia, Morocco), or the rather promising cases of cluster 5 (Egypt, Israel, Jamaica, Philippines, Vietnam). Uzbekistan, although being a member of the very unattractive group 7, seems to stick out from this group due to its tendency to belong to the countries which are attractive to a limited extent.

Figure 1 illustrates the classification of host countries by coloring countries according to their attractiveness for CDM non-sink investment. Thus, it provides a first picture of the probable geographical distribution of future CDM (non-sink) investment flows. The darker the color, the more attractive a country can be considered for non-sink CDM investment. The unstable cases, whose classification is affected by their instability, are presented separately (striped grey). [26]

The fact that relatively big countries belong to the category of the very attractive non-sink CDM host countries can be explained by the use of absolute GHG emissions as an indicator for mitigation potential. However, it is to be expected that a range of smaller countries (e.g. Costa Rica, Chile, Trinidad and Tobago) will be quite attractive for CDM non-sink investments as well. Furthermore, it has to be noted, that all the very attractive host countries, with the exception of South Africa, are located either in Latin America or Asia (mainly Central, East, South and South East Asia). Most of the host countries in Western Asia, and especially in Africa, do not seem to be very promising CDM candidates.

Assuming that future CDM (non-sink) investment flows will be directed mostly towards the host countries which have been classified as attractive and very attractive, it is likely that a relatively small proportion of all potential host countries will receive most of the CDM investment in the market. Furthermore, it can be expected that the geographical distribution of CDM flows will be concentrated in certain regions or even countries.

The above classification illustrates as well that the simplistic assumption of CDM following the same paths as traditional FDI flows, is a relatively good approximation - at least for those countries with the highest FDI attractiveness. From the countries included in the present analysis, China, India, Malaysia, Brazil, Thailand, Mexico and Indonesia are the developing countries with the highest FDI confidence index in 2004 (Kearney 2004). With the exception of Malaysia, all of these countries are as well classified as the most attractive CDM host countries.

[26] Results of the classification for each country are also presented in Appendix A.

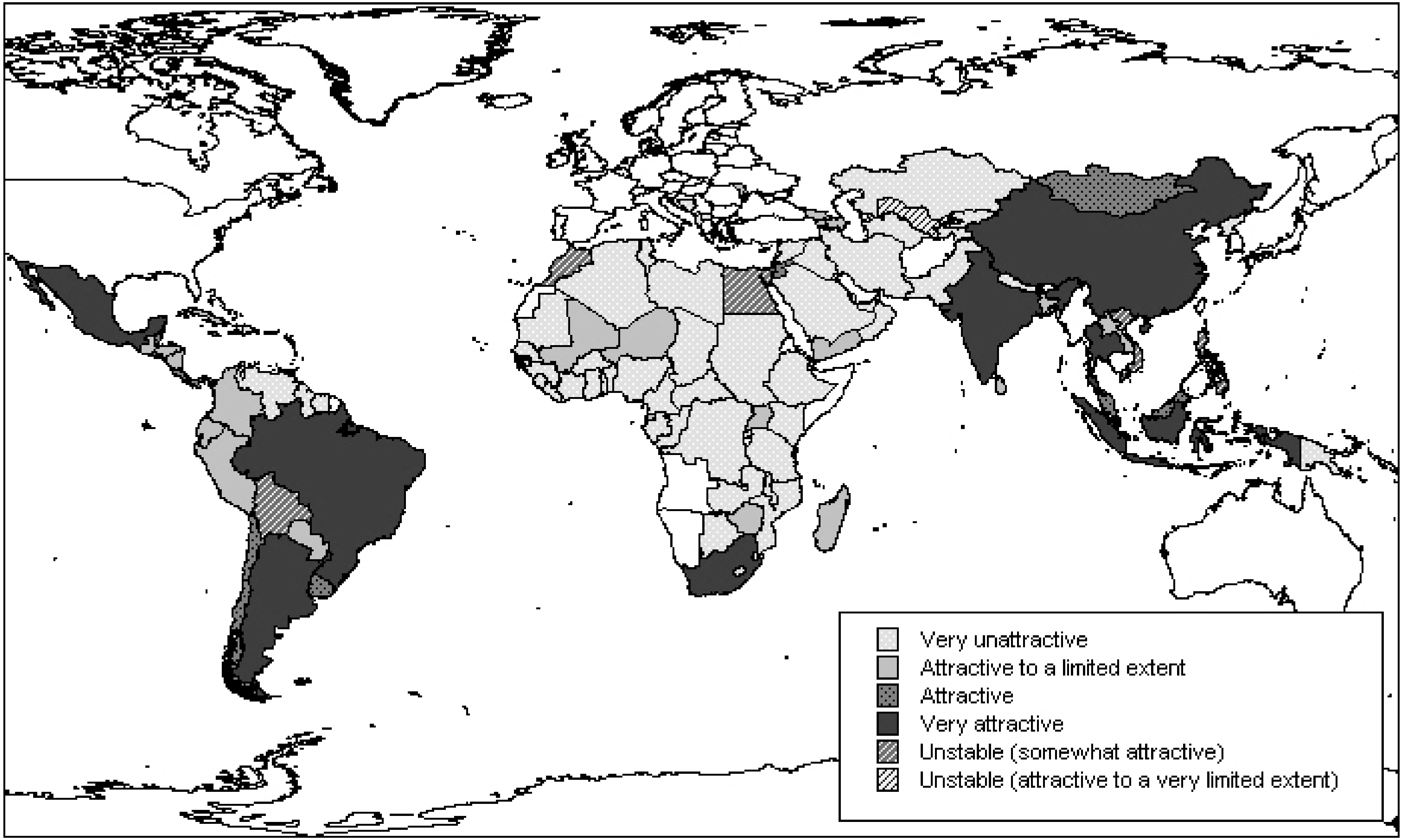

Figure 1: Map the host country classification

Current CDM project status

Being aware that the current distribution of CDM investment cannot be considered representative of the one in a mature market, it is still worth having a look at the current status of CDM projects with the CDM Executive Board. Figure 2 shows the expected amount of CERs generated from CDM projects by 2012 available for validation comments[27] on the UNFCCC CDM website by Feb. 10 2005. Assuming that the amount of CERs is positively correlated to the amount of investment in the respective project, Figure 2 can give an indication to which extent early CDM (non-sink) investment are compatible with my classification of host countries.

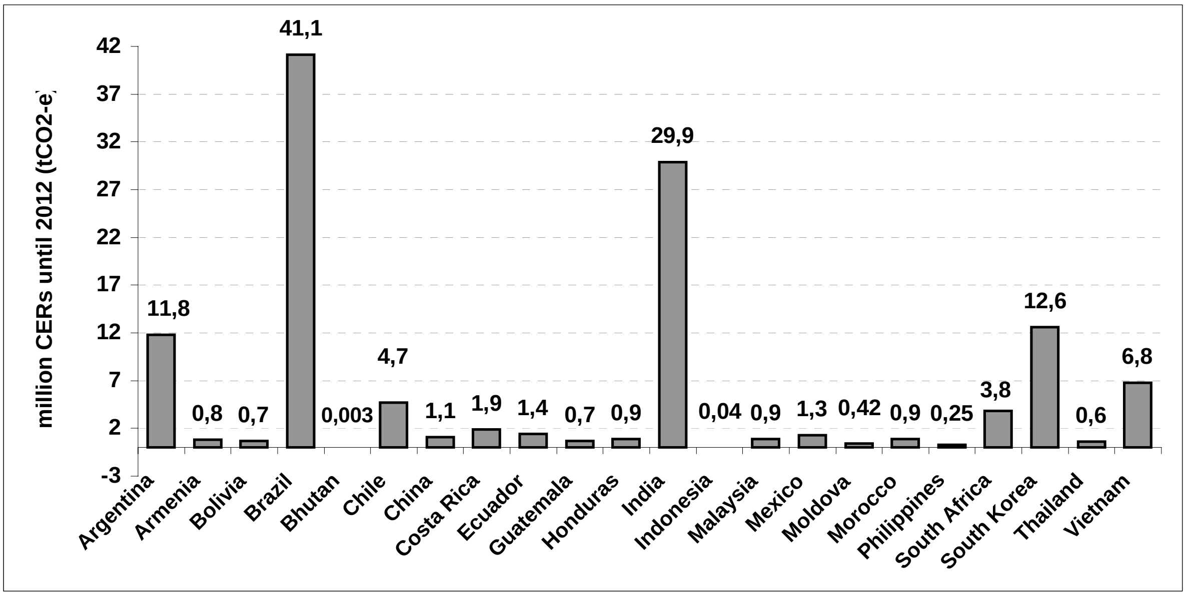

Figure 2: Expected amount of CERs generated from CDM projects by 2012 available for validation comments on the UNFCCC CDM website (10 Feb. 2005).

The countries with the biggest amount of CERs from non-sink CDM projects in the first commitment period are Brazil, India, South Korea and Argentina. While South Korea was not included in the present analysis, the other three have all been classified as very attractive host countries. The latter classification seems to be confirmed by the early CDM investments. China, Mexico, South Africa, Thailand and Indonesia are lagging behind as compared to their ‘CDM host country attractiveness’. However, only the fact that they belong to the first 22 countries with CDM projects at the current stage, is an indication that their attractiveness for CDM non-sink projects is considerable. Three of the smaller countries classified as ‘attractive’ (Chile, Costa Rica, Malaysia), as well as four of the ‘somehow attractive countries' (Bolivia, Morocco, Philippines, Vietnam) are also participating in the first phase of CDM project proposals. The remaining countries Armenia, Bhutan, Ecuador, Guatemala, Honduras and Moldova are all classified as countries 'attractive to a limited extent', with the exception of Bhutan which was not included in the present analysis.

This very first CDM project data shows quite some correspondence with the cluster analysis results. It has to be kept in mind, though, that we are in a very early phase of the CDM market. The few projects submitted so far can just give an indication, but cannot necessarily be considered representative of what a future distribution of CDM projects might look like.

Policy implications

The expectation that it might only be relatively few host countries receiving most of the CDM (non-sink) investment flows is not compatible with the above mentioned claim for an equitable geographical distribution of CDM project activities in the Marrakech Accords.[28]

Rules and modalities of the Kyoto Protocol like the exemption of CDM projects in least developed countries (LDCs) from the adaptation levy as well as the rules for small scale CDM projects aim at rendering CDM projects in less attractive host countries more attractive. However, it cannot be expected that they will considerably change the distribution of CDM investment flows. Measures like the improvement of the general investment climate are more long-term measures and more a development than a climate policy issue.

Consequently, of the three variables included in the cluster analysis, only the improvement of the CDM institutions and capacity by capacity building will be an appropriate measure available to climate policy for promoting a more equal distribution of CDM activities.[29] It has to be questioned, though, whether CDM capacity building makes sense in all cases. For host countries with a considerable mitigation potential and an acceptable investment climate, CDM capacity building will be promising in order to make these countries more attractive for private CDM investment. Countries whose mitigation potential is very small will, however,

[27] Includes submitted projects, those under review as well as registered ones.

[28] I am neglecting here, that my results are only valid for non-sink projects. Nevertheless, the overall distribution of CDM projects is unlikely to be distributed in a more equal manner than the results suggest for non-sink CDM projects.

[29] For details on the capacity building activities having taken place so far, see Michaelowa (2004).

not necessarily turn into attractive host countries if they build up a good institutional CDM capacity.[30]

When focussing only on the general investment climate, an increase in the CER price[31] appears to be another appropriate tool to achieve a more equitable distribution, since it will be able to compensate the higher risk of countries with rather bad investment climate, thus increasing investment into less attractive countries. However, this argument might not be as straightforward as it seems at first sight. With higher prices investors might as well prefer more costly options in already experienced and less risky host countries, which could lead to a further geographical concentration of CDM investment.

The above discussion leads to the conclusion that it is rather against the general principle of a market-based tool like the CDM to result in an equal geographical distribution of projects. Measures taken will probably be able to decrease the concentration of projects in certain countries and regions to a small extent, but will not solve the problem entirely. Considering that the CDM is a market-based tool, it might be more appropriate to ask for an equal distribution of CDM opportunities, rather than CDM project activities.

Advantages and limits of the approach chosen

Finally, I would like to discuss the strengths and weaknesses of the approach I have chosen for the present analysis. As it was the goal to include as many host countries in the analysis as possible, relatively few and rough indicators had to be used. Especially, the indicator for CDM capacity is only capable to a limited extent of measuring the quality of institutions. More details on the quality of CDM institutions can only be investigated by country case studies, which are currently available for few countries only.

Furthermore, relatively little is known on the relative importance of factors influencing CDM investment. In the present study, therefore, an equal weight of the three dimensions is assumed. In the future, further factors, e.g. host country climate project experience, might as well play a role for investors' decisions. However, the three selected indicators cover the most important dimensions of host country attractiveness. Host country ratings include similar dimensions, but were so far limited on the most promising host countries. Furthermore, the advantage of cluster analysis over rankings is that it uses a known concept for classifying host

[30] There might be even cases, where the costs of such capacity and institution building will by far outgrow any future CDM inflows. A case in point is Cambodia where about a million $ have flown into capacity building but which is utterly unlikely to generate any CDM projects.

[31] For example due to strict targets in a second commitment period.

countries, thus making the classification rule explicit. It has to be emphasized, though, that it is not free of subjectivity, as the researcher´s choice on the variables to be included, and the fusion algorithm to be used will influence the results. Therefore, host country ratings and a classification approach as the one chosen in the present analysis can be considered complementary tools, both with their own strengths and weaknesses.

Summary and conclusion

The present study uses cluster analysis for the classification of 114 potential CDM host countries based on their attractiveness for CDM non-sink projects. The three dimensions of host country attractiveness considered are the mitigation potential, the institutional CDM capacity and the general investment climate. Based on the combination of the three latter factors four levels of attractiveness are identified, and countries are classified according to their cluster memberships. Those cases which are very close to two clusters are classified separately as unstable cases.

The results suggest that the CDM investment in non-sink projects will be concentrated in rather few countries. The CDM (non-sink) stars are China, India, Brazil, Argentina, Mexico, South Africa, Indonesia and Thailand. They are followed by attractive countries like Costa Rica, Trinidad and Tobago, Mongolia, Panama, and Chile. While most of the promising CDM host countries are located in Latin America and Asia, the general attractiveness of African host countries is relatively low (with the exception of South Africa). These results have some policy implications, since it is expected that the inclusion of forestry projects in the CDM will not improve this inequitable geographical distribution.[32] One measure available to climate policy for the promotion of a more equal geographical distribution of CDM project activities - as asked for by the Marrakech Accords - is a well coordinated and planned CDM capacity building in host countries. In the short run, capacity building might contribute to mitigating the problem, without being able to solve it entirely. However, since the CDM is a market-based tool, it seems more appropriate to ask for an equal distribution of CDM opportunities, rather than CDM project activities.

[32] However, the inclusion of CDM forestry projects will increase CDM investment in the Latin American countries.

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Appendix A: Host country classification

Very attractive	Attractive	Attractive to a limited extent	Very unattractive
Argentina	Antigua and	Azerbaijan	Algeria, Albania
Brazil	Belize	Armenia	Bahrain, Botswana
India	Chile	Bangladesh	Bahamas
Mexico	Costa Rica	Sri Lanka	Bosnia and Herzegovina
South Africa	El Salvador	Colombia	Benin, Brunei
Thailand	Jordan	Cuba	Chad, Congo
China	Mongolia	Ecuador	Dem. Congo (Zaire)
Indonesia	Mauritius	Equatorial Guinea	Cameroon
	Maldives	Georgia	Central African Republic
	Malaysia	Guatemala	Cape Verde
	Panama	Honduras	Dominican Republic Ethiopia
	Trinidad and Tobago	Laos	Gambia, Gabon, Ghana
	Uruguay	Madagascar	Guinea, Guyana
		Moldova	Haiti, Iran
		Mali	Ivory Coast
		Niger	Iraq, Kenya
		Nicaragua	Kyrgyzstan, North Korea
		Paraguay	Kuwait, Kazakhstan
		Peru	Lebanon, Liberia, Lesotho
		Uganda	Libyan Arab.Yam., Malawi
		Yemen	Macedonia, Mauritania
		Zimbabwe	Oman, Mozambique
	Bolivia*		Nigeria, Nepal
	Egypt*		Suriname, Pakistan
	Israel*		Papua New Guinea
	Jamaica*		Guinea-Bissau
	Morocco*		Qatar, Rwanda
	Philippines*		Saudi Arabia, Seychelles
	Vietnam*		Senegal, Sierra Leone
			Sudan, Syria
			United Arab Emirates
			Tajikistan, Togo
			Sao Tome and Principe
			Tunisia, Turkmenistan
			Tanzania, Burkina Faso
			Venezuela, Zambia
		Uzbekistan**	

* somewhat attractive, **attractive to a very limited extent