

Assessing Global Environmental Sustainability Via An Unsupervised Clustering Framework

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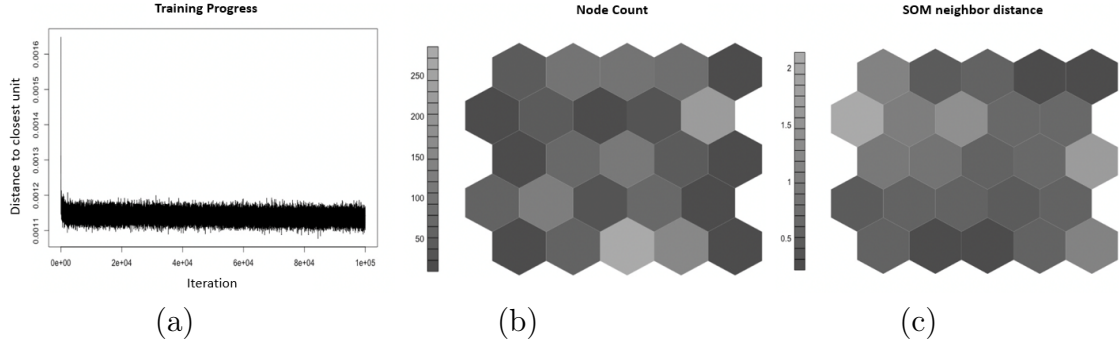


Figure S1: SOM Model Training and Convergence: (a) Training progress, (b) Node Counts, (c) SOM neighbor distance

Post hyperparameter tuning, the SOM model obtained at the optimum learning rate (0.03359) and optimum radius (1) is represented in Figure S1. The training progress plot in Figure S1(a) verifies that the model has converged at the optimum hyperparameters. The distance to closest cluster remains constant indicating that the clusters are formed such that data points are at the least value of closest distance. In Figure S1(b), the node count variation is represented with lighter shade corresponding to higher number of countries and darker shade corresponding to lesser node of countries. Similarly, in Figure S1(c), the SOM neighbor distances are represented with lighter shade corresponding to higher distance between countries within a node and darker shade corresponding to lower distance between countries within a node. It can be observed that the node code variation in part (b) and neighbor distances in part (c) have a tendency to contrast each other - densely occupied nodes are closely packed and vice versa.

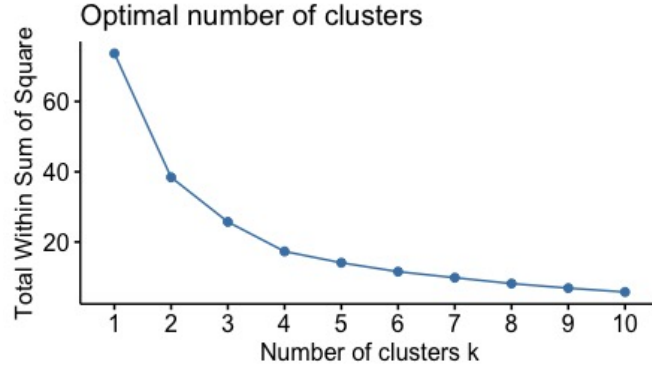


Figure S2: Hierarchical clustering evaluation

Using the neighbour distance from the model, the tendency for hierarchical clustering of the nodes is checked in Figure S2. Decision regarding number of clusters has always been ambiguous. Based on the plot, the number of clusters is fixed as 6 (with precaution). Since the hierarchical clustering is used as techniques to analyze the nodes and not the data directly, this number of clusters is for the purpose of each of analyzing the nodes. It does not affect the SOM model which has been constructed from the data.

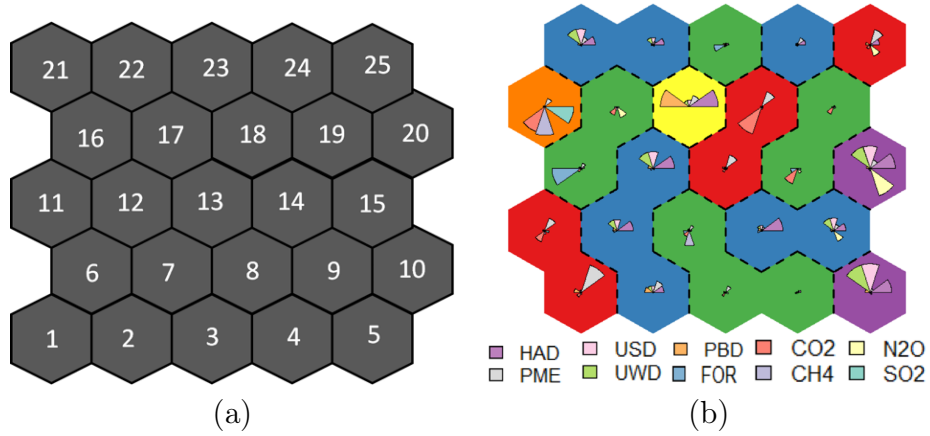


Figure S3: (a) Node location reference numbers and (b) values of each indicator within a given node.

Table S1: List of countries and their respective node locations from 2001 to 2010. See Figure S3 for the corresponding numbers and indicator values to the listed locations.

Country	Node Location									
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Afghanistan	18	18	18	18	18	18	18	18	18	18
Albania	4	4	4	4	4	4	4	4	4	4
Algeria	13	3	3	3	3	3	3	3	3	3
Angola	12	12	12	21	21	21	21	21	21	21
Antigua and Barbuda	3	3	3	3	3	3	3	3	3	3
Argentina	4	4	4	20	20	20	20	20	20	20
Armenia	24	24	13	13	13	13	13	13	13	13
Australia	17	17	17	17	17	17	17	17	17	14
Austria	20	20	20	20	20	20	20	20	20	20
Azerbaijan	13	13	13	13	13	13	13	13	13	13
Bahamas	3	3	3	3	3	3	3	3	3	3
Bahrain	19	19	19	19	19	19	19	19	19	19
Bangladesh	2	2	2	2	2	2	2	2	2	2
Barbados	3	3	3	3	3	3	3	3	3	3
Belarus	13	13	13	13	13	13	13	13	13	13
Belgium	20	20	20	20	20	20	20	20	20	20
Belize	8	8	8	8	8	8	8	8	8	8
Benin	7	7	7	7	7	7	7	7	7	7
Bhutan	24	24	24	24	24	24	24	24	24	24
Bolivia	24	24	24	24	24	24	24	23	4	23
Bosnia and Herzegovina	4	3	3	3	3	3	3	3	3	3
Botswana	10	10	22	22	22	22	22	17	22	17
Brazil	23	23	23	23	23	23	23	23	4	23
Brunei	8	8	8	8	8	8	8	8	8	8
Bulgaria	3	3	3	3	3	3	3	3	3	3
Burkina Faso	12	12	12	12	12	12	7	7	7	7
Burundi	12	12	12	7	7	7	7	7	7	7
Cambodia	9	9	9	9	9	9	9	9	23	11
Cameroon	10	10	10	10	10	10	10	10	10	10
Canada	14	14	14	14	14	14	14	14	14	14
Cape Verde	4	4	4	4	4	4	4	4	4	4

Central African Rep.	15	15	15	15	15	15	15	15	15	15
Chad	5	5	5	5	5	5	5	5	5	5
Chile	4	4	4	20	20	20	20	20	20	20
China	24	24	13	13	3	3	3	3	3	3
Colombia	4	4	4	4	4	4	4	4	4	4
Comoros	7	7	7	7	7	7	7	22	22	22
Congo	7	21	21	21	21	21	21	21	22	22
Costa Rica	23	4	4	4	23	4	4	23	23	4
Côte d'Ivoire	7	7	7	7	7	7	7	7	7	7
Croatia	3	3	3	3	3	3	3	3	3	3
Cuba	3	3	3	3	3	3	3	3	3	3
Cyprus	3	3	3	3	3	20	20	20	20	20
Czech Rep.	20	20	20	20	20	20	20	20	20	20
Denmark	20	20	20	20	20	20	20	20	20	20
Djibouti	22	22	22	22	22	22	22	24	24	24
Dominica	4	4	4	4	4	4	4	4	4	4
Dominican Rep.	4	4	4	23	23	23	23	23	23	23
Ecuador	4	4	4	4	4	4	4	4	4	4
Egypt	1	1	1	1	1	1	1	1	1	1
El Salvador	23	4	23	4	23	4	4	4	4	4
Equatorial Guinea	22	22	22	8	8	8	8	8	8	8
Eritrea	21	21	21	21	21	21	21	21	21	21
Estonia	14	14	14	14	14	14	14	14	14	14
Ethiopia	12	12	7	7	7	7	7	7	7	7
Fiji	24	24	24	24	24	24	24	24	24	24
Finland	14	14	14	14	14	14	14	14	14	14
France	20	20	20	20	20	20	20	20	20	20
Gabon	13	13	13	13	13	13	13	13	13	13
Gambia	7	7	7	7	7	22	22	22	22	22
Georgia	24	24	24	24	4	4	4	4	4	4
Germany	20	20	20	20	20	20	20	20	20	20
Ghana	22	22	22	22	22	22	22	22	22	22
Greece	20	20	20	20	20	20	20	20	20	20
Grenada	8	8	8	11	8	8	8	8	8	8
Guatemala	22	22	11	23	11	23	11	23	23	23
Guinea	12	12	12	12	12	7	7	7	7	7
Guinea-Bissau	12	12	12	12	12	12	12	12	12	12

Guyana	13	13	13	13	13	13	13	13	13	13
Haiti	7	7	7	7	7	7	7	7	7	7
Honduras	23	23	23	23	23	23	23	23	23	23
Hungary	3	3	3	3	3	3	3	3	3	3
Iceland	20	20	20	20	20	20	20	20	20	20
India	2	2	2	2	2	2	2	2	2	2
Indonesia	23	23	23	23	23	23	23	23	11	23
Iran	3	3	3	3	3	3	3	3	3	3
Iraq	1	1	1	1	1	13	13	13	13	13
Ireland	17	17	17	17	17	17	17	17	17	17
Israel	20	20	20	20	20	20	20	20	20	20
Italy	20	20	20	20	20	20	20	20	20	20
Jamaica	3	3	3	23	23	3	3	3	3	3
Japan	20	20	20	20	20	20	20	20	20	20
Jordan	13	13	13	13	13	13	3	3	3	3
Kazakhstan	6	6	6	6	6	6	6	6	6	6
Kenya	7	7	22	22	22	22	22	22	22	22
Kiribati	9	9	9	9	9	9	9	9	9	9
Kuwait	16	16	16	16	16	16	16	16	16	16
Kyrgyzstan	24	24	24	24	24	24	24	24	24	24
Laos	9	9	9	9	9	9	9	9	9	9
Latvia	23	23	3	23	23	23	23	23	23	23
Lebanon	3	3	3	3	3	3	3	3	3	3
Lesotho	21	21	21	21	21	21	21	21	21	21
Liberia	12	12	12	7	7	7	7	7	7	7
Libya	6	6	6	6	6	6	6	6	6	6
Lithuania	3	3	3	3	3	3	3	3	3	3
Luxembourg	14	14	14	14	14	14	14	14	14	14
Macedonia	3	3	3	3	3	3	3	3	3	3
Madagascar	12	12	12	12	12	12	12	12	12	12
Malawi	12	12	7	7	7	7	7	7	7	22
Malaysia	11	11	23	11	11	11	11	11	11	11
Maldives	4	4	4	4	4	4	4	4	4	4
Mali	5	5	12	12	12	12	12	7	7	7
Malta	3	3	20	20	20	20	20	20	20	20
Mauritania	21	21	21	21	21	22	22	22	22	22
Mauritius	3	3	3	3	3	3	3	3	3	3
Mexico	3	3	3	3	3	3	3	3	3	3
Micronesia	24	24	24	24	24	24	24	24	24	24
Moldova	24	24	24	24	3	3	3	3	3	3

Mongolia	25	25	25	25	25	25	25	25	25	25
Morocco	13	13	13	13	13	13	13	13	13	13
Mozambique	7	7	7	7	7	7	7	7	7	7
Myanmar	9	9	9	9	9	2	24	24	24	24
Namibia	22	22	22	22	22	22	22	22	22	22
Nepal	2	2	2	2	2	2	2	2	2	2
Netherlands	20	20	20	20	20	20	20	20	20	20
New Zealand	17	17	17	17	17	17	17	17	17	17
Nicaragua	23	23	23	4	23	23	23	23	23	11
Niger	5	5	5	5	5	5	5	12	12	12
Nigeria	21	21	21	21	21	21	21	21	21	21
North Korea	24	24	24	24	24	24	24	24	24	24
Norway	20	20	20	20	20	20	20	20	20	20
Oman	6	6	6	6	6	6	6	6	6	6
Pakistan	2	2	2	2	2	2	2	2	2	2
Panama	4	4	4	4	4	23	4	23	23	4
Papua New Guinea	9	9	9	9	9	9	9	9	9	9
Paraguay	23	23	23	23	23	23	11	11	23	11
Peru	4	4	4	4	4	4	4	4	4	4
Philippines	24	24	24	24	24	24	24	24	24	24
Poland	3	3	3	3	3	3	3	3	3	3
Portugal	20	23	20	23	23	23	23	23	23	23
Qatar	19	19	19	19	19	19	19	19	19	19
Romania	3	3	3	3	3	3	3	3	3	3
Russia	6	6	6	6	6	6	6	6	6	6
Rwanda	12	12	12	7	7	7	7	22	22	22
Saint Lucia	3	3	3	3	3	3	3	3	3	3
Saint Vincent and the Grenadines	4	4	4	3	3	3	3	3	3	3
Samoa	4	4	4	4	4	4	4	4	4	4
São Tomé and Príncipe	7	22	22	22	22	22	22	22	22	22
Saudi Arabia	6	6	6	6	6	6	6	6	6	6
Senegal	21	7	7	7	7	22	22	22	22	22
Serbia	3	3	3	3	3	3	3	3	3	3
Seychelles	3	3	3	3	3	3	3	3	3	3
Sierra Leone	12	12	12	12	12	12	12	12	7	7
Singapore	3	20	20	20	20	20	20	20	20	20

Slovakia	3	3	3	3	23	3	3	3	3	3
Slovenia	20	20	20	20	20	20	20	20	20	20
Solomon Isl.	9	9	9	9	9	9	9	9	9	9
Somalia	12	12	12	12	12	12	12	12	12	12
South Africa	13	13	13	13	13	13	13	13	13	13
South Korea	20	20	20	20	20	20	20	20	20	20
Spain	20	20	20	20	20	20	20	20	20	20
Sri Lanka	4	4	4	4	4	4	4	4	4	4
Suriname	3	3	3	3	3	3	3	3	3	3
Sweden	20	20	20	23	23	23	23	23	23	23
Switzerland	20	20	20	20	20	20	20	20	20	20
Syria	13	13	13	13	13	13	13	13	13	13
Tajikistan	2	2	2	2	2	2	13	13	13	13
Tanzania	7	7	22	22	22	22	22	22	22	22
Thailand	4	4	4	4	4	4	4	4	4	4
Togo	7	7	7	7	7	7	7	7	7	7
Tonga	4	4	4	4	4	4	4	4	4	4
Trinidad and Tobago	6	6	6	6	6	6	6	6	6	6
Tunisia	3	3	3	3	3	3	3	3	3	3
Turkey	13	13	13	3	3	3	3	3	3	3
Turkmenistan	1	1	1	1	1	1	1	1	6	6
Uganda	7	7	22	22	22	22	22	22	22	22
Ukraine	13	13	13	13	13	13	13	13	13	3
United Arab Emirates	19	19	19	19	19	19	19	19	19	19
United King.	20	20	20	20	20	20	20	20	20	20
United States	14	14	14	14	14	14	14	14	14	14
Uruguay	17	17	17	17	17	17	17	17	17	17
Uzbekistan	13	13	13	13	13	13	13	13	13	13
Vanuatu	9	9	9	9	9	9	9	9	9	9
Venezuela	3	3	3	3	3	3	3	3	3	3
Vietnam	4	4	4	4	23	4	4	23	23	23
Yemen	2	2	2	2	2	2	2	2	2	2
Zambia	12	10	10	10	10	10	10	10	10	10
Zimbabwe	22	22	22	22	9	9	9	7	7	9
