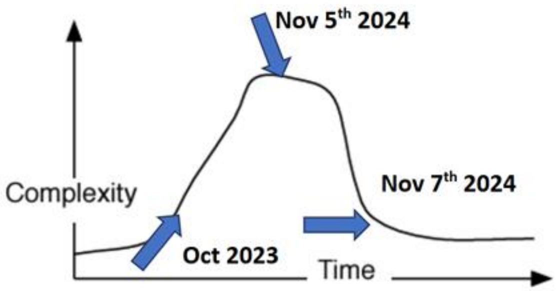
CoRE Stack: Workshop – Landscape Solvability

Ground floor, SIT building, IIT Delhi

November 5-7, 2024

This is a short report of key learnings from the landscape solvability workshop in November 2024. We had an ambitious agenda and got into the workshop with a clear understanding that we were attempting something quite complex with describing landscapes in terms of dozens of data variables, but had to discover how to simplify this so that community stewards – volunteers and frontline workers trained on the basics of socio-ecological management of landscapes – could translate the data into actionable insights. In Oct 2023, we documented 80+ socio-ecological variables to characterize landscapes, and in the last one year we built many of them out primarily using secondary and remote sensing data, and our goal during the workshop was to ride the rollercoaster to bring down this complexity in three days!



And we did! It was nothing short of a breakthrough of how to think about landscapes and data. Read on.

Data familiarization: The first half of the day was mostly spent on familiarizing everyone with the datasets. We had 11 partners who came from 11 different locations, prepared with a deep understanding of their landscapes, and for which we had prepared datasets in advance. The partners, with guidance from various domain experts, examined the datasets and gave valuable feedback on what was right, what was inaccurate, and new kinds of data that would make sense to build. The development team has since then been following up with the partners to track this.

It was also recognized that many secondary datasets are locked within government websites and should be accessible easily through APIs or shared databases. Participants volunteered to front some of these efforts. If you are eager to help then please write back!

Socio-ecological patterns: The participants then started listing out specific problems and interventions they had adopted in their landscapes, and attempted to write out in terms of data variables how a particular diagnosis could be attached to a landscape and a meaningful intervention strategy could be recommended. Various patterns like how to recognize groundwater stress, understand the suitability of an area for tree plantations, recognize the need for ridge to valley treatments, etc. were listed and mentioned alongside data variables for these patterns. The breakthrough in our thinking really came a couple of days later when we realized that we had essentially developed a language to describe micro-watersheds, which are the landscape unit we are building for right now. See this screenshot of an Excel sheet, for example.

UID	area_in_hac	terrainCluster_ID	Terrain_Description	% of area hill_slope	% of area plain_area	% of area ridge_area	% of area slopy_area	% of area valley_area
12_305795	771.7283439	3	Broad Plains and Slopes	11.13133132	51.01650844	7.685622448	17.24519018	12.92134761
12_307609	2116.443393	3	Broad Plains and Slopes	4.597655926	60.34905751	7.144276834	24.73331744	3.175692283
12_308492	1410.86473	3	Broad Plains and Slopes	3.435826316	60.82968506	5.580878356	26.63604269	3.517567582
12_308948	1618.368478	1	Mostly Plains	1.036581458	81.10297411	2.609962542	10.80531189	4.445169997
12_309695	1554.517784	1	Mostly Plains	0.102937308	91.21269304	5.630214303	0.81528046	2.238874889
12_312558	1850.151769	1	Mostly Plains	1.139574374	78.5543311	2.510694645	16.21628195	1.579117937
12_313014	1961.218626	1	Mostly Plains	0.1	80.58001458	4.564092016	12.27097908	2.446518999
12_313277	760.2056969	1	Mostly Plains	0.329058616	78.74355972	1.140672985	19.20254793	0.584160751
12_314843	1620.686474	3	Broad Plains and Slopes	4.211006838	66.03146704	5.762059814	19.50627148	4.489194823
12_315140	2457.589854	3	Broad Plains and Slopes	4.3135216	58.51832292	7.265600805	26.10417438	3.798380299
12_317063	1782.290065	1	Mostly Plains	2.06408291	75.32795853	2.262093402	18.52487842	1.820986729
12_318533	2342.956564	1	Mostly Plains	0.804574826	76.15909258	8.009838118	12.27945527	2.747039204
12_318789	707.307987	3	Broad Plains and Slopes	6.344315948	60.52906758	7.611164907	21.49531005	4.020141518
12_319549	2289.498236	1	Mostly Plains	0.186632809	78.5696694	6.377646714	11.4909067	3.375144381
12_319785	632.0660833	3	Broad Plains and Slopes	9.593165773	45.41874127	11.60675921	25.0773509	8.303982846
12_320259	649.7575988	1	Mostly Plains	0.07592989	82.47054401	3.390070934	13.51256624	0.550888923
12_320690	728.8831499	1	Mostly Plains	0.013539865	84.16234144	2.063920217	13.51031238	0.249886095
12_320895	2286.799688	1	Mostly Plains	0.190609192	77.8526656	4.540824076	13.47771444	3.938186696
12_321768	788.1564991	1	Mostly Plains	0	76.30809418	3.62534616	18.585984	1.480575656
12_322030	1635.946028	1	Mostly Plains	0.066137631	75.74790587	4.190259891	16.00456143	3.99113518
12_322313	1073.765148	1	Mostly Plains	1.266858431	79.88045309	2.374405725	15.41209644	1.066186308
12_322520	973.068288	1	Mostly Plains	0.134190242	79.85785758	4.874302175	14.09926734	1.034382654

This lists out all micro-watersheds in a block (sub-district), and for each MWS it gives the area, the dominant terrain type, and the area under different terrains. Next, add to this the annual and seasonal water balance for each MWS.

UID	ET_2017-2018	RunOff_2017-2018	G_2017-2018	DeltaG_2017-2018	Precipitation_2017-2018	WellDepth_2017-2018	ET_2018-2019	RunOff_2018-2019
12_305795	1012.609961	158.3422909	34.62982321	34.62982321	1205.582075	2.807460073	988.9283073	119.818462
12_307609	1139.861533	141.138004	-75.41746229	-75.41746229	1205.582075	-4.227721714	1113.923583	113.0665686
12_308492	1030.522576	153.7177958	22.08378217	22.08378217	1206.324154	1.129842835	1011.349752	116.276967
12_308948	711.6951806	116.3562464	372.8205712	372.8205712	1200.871998	19.43418191	697.8839689	88.85475378
12_309695	1724.847771	21.89716646	-546.2648006	-546.2648006	1200.480137	-27.69220321	1677.906346	17.33834528
12_312558	1062.6774	174.1787489	-49.61256554	-49.61256554	1187.243584	-2.523835496	1044.788955	133.0916771
12_313014	1333.000576	191.8399076	-313.1558604	-313.1558604	1211.684623	-15.76336027	1310.042545	124.6644437
12_313277	1537.113037	162.6034379	-512.4728908	-512.4728908	1187.243584	-26.02999717	1516.379165	120.0960383
12_314843	1183.233379	179.3429575	-157.2550644	-157.2550644	1205.321272	-8.061476258	1167.858563	129.2593719
12_315140	1033.91051	172.3432339	2.390879785	2.390879785	1208.644623	0.129933189	1015.790568	123.4832112
12_317063	1068.567704	235.8507351	-90.43212538	-90.43212538	1213.986313	-4.639733801	1043.775392	146.9143493
12_318533	974.3903385	219.855799	19.61362546	19.61362546	1213.859763	0.981159508	958.1519932	140.8153107
12_318789	965.0137407	172.8783963	70.90561375	70.90561375	1208.797751	3.545280687	948.9792673	116.8757782
12_319549	1049.258857	230.568097	-50.87253067	-50.87253067	1228.954424	-2.543626534	1036.122796	141.2157635
12_319785	1258.848014	164.019877	-214.07014	-214.07014	1208.797751	-10.92168977	1242.71461	113.8057594
12_320259	1078.084611	229.8838015	-76.97402773	-76.97402773	1230.994384	-3.848701386	1066.826169	137.8207945
12_320690	1006.308955	258.9882504	-0.286678614	-0.286678614	1265.010527	-0.014615813	994.3280106	139.0868268
12_320895	1181.322746	274.4050851	-190.7173043	-190.7173043	1265.010527	-9.797335599	1159.399046	145.7857433
12_321768	1095.822294	288.6404699	-119.4522369	-119.4522369	1265.010527	-6.079723066	1071.08796	153.5570586
12_322030	1143.127644	274.399468	-153.3568609	-153.3568609	1264.170251	-7.685938201	1116.225394	143.7113307
12_322313	1121.360593	212.9790934	-109.6114329	-109.6114329	1224.728253	-5.933955957	1097.847411	128.717293
12_322520	1009.155363	228.4898231	-7.54596311	-7.54596311	1230.099223	-0.389771413	995.1108159	139.0969066

And then the area under different cropping intensities.

	A	B	C	D	E	F
1	UID	area_in_ha	cropping_intensity_2017-2018	single_cropped_area_2017-2018	single_kharif_cropped_area_2017-2018	single_non_kharif_cropped_area_2017-2018
2	12_305795	771.7283439	1.245994552	24.94320066	24.94320066	0
3	12_307609	1586.577843	1.0356859	81.27361394	81.14646263	0.127151311
4	12_308492	1410.86473	1.24247935	80.5694037	80.396844	0.172559695
5	12_308948	2497.924435	1.123012109	211.4762678	210.7882771	0.687990704
6	12_309695	1554.517784	0.315147391	17.4370827	17.36353785	0.073544847
7	12_312558	1301.5114	1.245556848	81.33731062	81.10125397	0.23605665
8	12_313014	1973.959038	1.240931279	179.5106212	179.0434185	0.467202757
9	12_313277	760.2056969	1.093112926	76.87459455	76.8201109	0.05448365
10	12_314843	1295.401279	1.252861756	85.66658576	85.48497072	0.181615038
11	12_315140	2469.315718	1.213423028	168.7246305	168.4339806	0.290649942
12	12_317063	1782.290065	1.206426311	435.3817433	435.1273743	0.254368913
13	12_318533	2342.956564	1.138910623	563.1837689	561.9347871	1.248981841
14	12_318789	1041.131119	1.172102799	121.2194346	120.79117	0.428264629
15	12_319549	1940.668847	1.210204127	496.197202	495.2639258	0.933276277
16	12_319785	628.7015043	1.196542684	32.63970151	32.61245703	0.027244476
17	12_320259	649.7575988	1.510679527	70.59944804	70.29979037	0.299657674
18	12_320690	728.8831499	1.247049799	154.409956	153.8198134	0.590142596
19	12_320895	2286.799688	1.243454807	673.0067484	671.0368598	1.96988861
20	12_321768	721.5492133	1.236853518	201.1889593	201.1435646	0.045394732
21	12_322030	1642.545512	1.186246308	502.2420511	501.7516187	0.490432357
22	12_322313	1140.372434	1.136240622	213.4634471	212.8958483	0.567598724
23	12_322520	973.068288	1.266021033	204.7605993	204.2429773	0.517622056

All of these variables are actually computed using numerous geospatial algorithms, machine learning on satellite data, etc., some of which are outlined in our recent paper, but when we put them out like this we suddenly realized that we can describe socio-ecological patterns using the same variables too! Areas in Odisha where ridge to valley treatment could be useful can be written out like this.

Rainfall > 1000mm AND Terrain == Hills & Valleys AND LULC_Hills_Trees > 50% AND LULC_Plains_Crops > 50% AND Single cropping > 40% => Ridge-to-Valley treatment

Areas in Bihar with extensive groundwater stress can be written like this.

Rainfall < 1000mm AND Terrain == Plains AND Double cropping > 80% AND Groundwater levels == Declining => Precision irrigation and groundwater usage norms

Similarly, we can describe areas where tree plantations under NREGA would be useful. And we can take this further – we can also describe different ecotypes such as the following – emerging from further ideas at the Restoring Natural Ecologies conference recently:

Orans in Thar: Tracts of shrubby land with sparse trees, used for grazing by livestock. Arid climate. Organizations like KRAPAVIS work with local communities to build commons rules for controlled grazing and to check the decline in land degradation and biodiversity. Such orans are home to the threatened Great Indian Bustard.

Shola forests in the Nilgiris: High elevation slopes, covered with forests adjacent to grasslands. Wet climate. Organizations like Keystone Foundation run experiments with local communities to improve the forest cover and keep a check on overgrazing in the grasslands.

Bare hilltops in the Shivaliks: Frequent fires to flat hill-tops to clear land for new grasses for grazing, have eroded the soil and left the hilltops bare with extensive soil erosion. Organizations like 14 Trees are foresting the hilltops by creating soil and water conservation structures, while also generating employment for local communities.

All sorts of geomorphologies, frequency of land burning, cropping patterns, adjacency of different land-uses… can be computed and listed out as a socio-ecological pattern! Computationally, patterns can be defined as a logical expression of conjunctions and disjunctions of variables.

Know Your Landscape: This brings us to a sprint we are starting next week between the CoRE development team and WELL Labs, which will allow people to discover problem diagnosis and interventions in their blocks, towards building a Digital Block Resource Center (BRC), and define their own patterns, share with others, and attach knowledge resources and reports to these patterns. The foundational underlying language of data variables will make all this possible by building a common vocabulary to describe landscapes. Stay tuned for a transformed Landscape Explorer dashboard in just a few weeks!

Do write back if you find this interesting and would be interested in testing and co-creating this model.

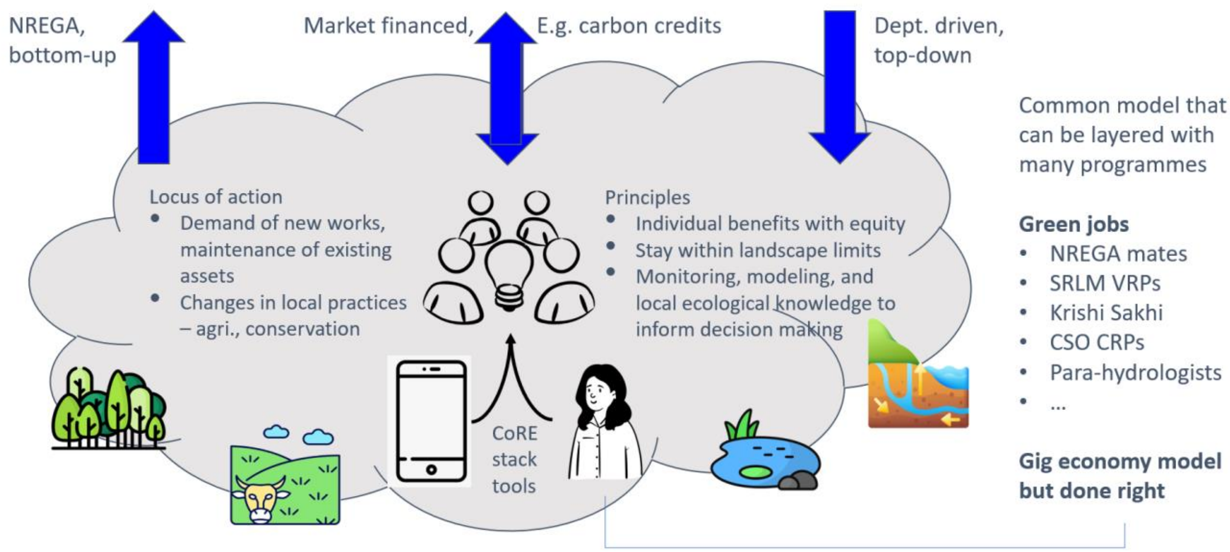
Data stories and narratives: On day-2, we started thinking about how community stewards can communicate such patterns to communities. The setting all of us imagined is when a community steward is in a village and interacting with the community members, what initial familiarity should they have with the landscape to be able to trigger a good discussion, uncover problems to get to a shared understanding, and discuss potential action strategies. Templates emerged of how to tell such data stories for different socio-ecological patterns, like to illustrate through examples from similar landscapes of before and after change maps, contrast the area with the broader block or district or state or national average, and describe this through charts and numbers. An interesting observation from everyone was that communties are quite number savvy, i.e. they like to think in terms of numbers – how many farm ponds, how much of cost saving, how much income, how much groundwater usage, etc. We are now working towards building out these data stories for which we will also leverage generative AI methods to write out pattern narratives automatically, show graphs and maps, and do an automated text-to-speech conversion to read out the narratives and data.

Communicate through stories to collectivize – other places with similar patterns, before/after, etc.

Community stewards as a common layer: As participants spoke about the diversity of intervention methods that their respective organizations had adopted – some with directly working on the ground, some via government cadre, some as part of specific pre-defined programmes – the common underlying layer that emerged was that of community stewards. None of the interventions could really succeed without a strong community connect, which could also persist beyond the intervention, and participants recognized that all of them indeed did work with such a cadre albeit with different names like CRPs, VRPs, volunteers, mates, and so on. This again helped provide a common language that many CoRE stack tools being developed should be envisioned as being put in the hands of stewards who can:

- Collectivize their communities towards coordinated landscape action by building a shared understanding of the communities about their landscapes.
- Facilitate informed decision making to build action plans that can improve the effectiveness in utilization of government schemes and other landscape financing initiatives.
- Strengthen local governance and accountability to bring greater equity and participation for marginalized communities.

- Facilitate implementation of accepted action plans by helping with local coordination, prompt timelines, and advisory.



A common problem that was also recognized was that of financial sustainabiity of the stewards, beyond project funding periods. The CoRE stack network will work further on this in subsequent workshops. Additionally, we will try to come up with common underlying socio-ecological principles that all community stewards, irrespective of whether they are embedded in civil society orgaizations, or working as independent activists, or as extension workers in government schemes, can follow.

Learning resources and systems for community stewards: In the second session on day-2 we discussed the need for learning resources for community stewards and tested a new chatbot to respond to technical questions about aquifers, checkdams, mulching, and a range of other topics. Participants shared several requirements they would like the chatbot to service, and we will be building this out in the coming months.

Some participants volunteered to collect resources like videos and training manuals on different aspects of natural resource management, which perhaps could be indexed and made searchable to respond to queries from community stewards. Do let us know if you are keen to help build this out.

Project planning and the next steps: Finally on day-3, we discussed with all the partners about using the CoRE stack tools in their work, minor modifications to data collection forms suited to their respective locations, etc. We are eagerly looking forward to seeing these tools get used and improved through continuous feedback.

About the CoRE stack

The CoRE Stack (Commoning for Resilience and Equality) is being architected as a digital public infrastructure consisting of datasets, pre-computed landscape level indicators, and tools that can be used by rural communities and other stakeholders to improve the sustainability and resilience of their local landscapes. It will enable innovators to build upon and contribute their own datasets, use APIs for third-party apps, and track and monitor socio-ecological sustainability through a systems approach. The CoRE stack broadly consists of four layers. First, using ML on satellite imagery we are producing novel geo-spatial layers on changes over the years in cropping intensity, water-table levels, health of waterbodies, forests and plantations, and welfare fund allocation, among others. Second, these will help generate rich analytics on diverse socio-ecological indicators, including fairness and equity in resource distribution. Third, a flagship tool, Commons Connect, is being built as a participatory platform using the datasets and indicators to enable communities to learn and understand more about their landscape, report new insights, and plan for sustainable management of natural resources including groundwater and forests. Fourth, tools such as Common Connect will have relevant plugs to integrate their outputs, including community demands, for funding under government programmes, and in the future, market driven initiatives as well.

The CoRE Stack is being developed in a collaborative co-creation manner with a large number of partners who are bringing their respective expertise together, unified by a common vision to find effective ways to leverage data and technology for climate action and environmental sustainability. The collaboration network includes IIT Delhi, WELL Labs, FES, WASSAN, PRADAN, Magasool, Viksit Labs, Saarland University, CommonsTech Foundation, Gram Vaani, SUPPORT, Tarkam, ATREE, Say Trees, among others, and has been supported financially by the Rainmatter Foundation, GIZ, Common Ground, Rohini Nilekani Philanthropies, Tower Research, Hellermann Tyton, Tarides, IIT Delhi, and R Systems.

Past workshops organized / facilitated by the CoRE stack for vision alignment, discovery of use-cases, solution methodology, and feedback:

- Kickoff! June 2023. With IITD, FES, Magasool, GIZ, Gram Vaani: Presentations, notes
- Thinking in terms of use-cases. Dec 2023. Workshop lead - CEEW: Link
- Research to Impact Collaborative, as part of the ACM COMPASS conference, July 2024
- Vision alignment. Commons Convening, Sept 2024: Agenda