A Governance Index Modelling Of Public Sector Institutional Capacities For Modern Agriculture And Climate Compatible Development

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Abstract

Institutional capacities refer to inherent characteristics that empower actors to respond to short and long term impacts. A vast majority of agricultural economies are in the developing phase where government departments have inadequate technological, financial and human resource capacities to cope with the challenges of climate change in 21st century. Policies and strategies designed in response to vulnerabilities focus on modern climate compatible and smart agriculture practices based on the "triple-win" approach. Modern farming offers solutions based on 'climate smart agriculture (CSA)' practices by ensuring food security, enhancing resilience and reducing greenhouse gases. Government line departments are key actors with a significant role in CSA and their capacities need to be up to the mark. Like other developing countries, the agriculture sector in Pakistan is also at high risk due to high climate vulnerability index and low capacities to cope with the challenge. This paper aimed at assessing the capacity of line government departments in the agriculture sector of Pakistan by developing and employing an innovative mix-method governance analysis model. It combines principles, criteria and indicators along-with integration of MCDA's SMART for cross-section data collected through 340 KIIs and 17 FGDs. Analysis model proved well to answer the question 'whether capacity of the line departments involved in agriculture governance is adequate to achieve the target of SDGs 2, 13, 14, and 15 for climate compatible development?' Statistically validated empirical results reveal that the existing capacity of line government departments is not adequate to deal with the agenda of climate compatible development in the agriculture sector of Pakistan.

Keywords: modelling actors' capacity; governance index; modern agriculture; crop emissions; climate compatible development; MCDA

Introduction

Climatic conditions play critical role in agriculture productivity of any area (Amir et al., 2020a; Amir et al., 2020b; FAO, 2017 and Iqbal & Khan, 2018). Plant growth depends on climatic variables like temperature, sunlight, carbon dioxide and water availability. Due to this very reason, a slight change in climatic variables can disrupt their processes (Niu et al., 2014). Besides that, agriculture sector is also affected by extreme events like floods, heat waves, erratic rainfall patterns, storms and droughts which may be induced by climate change and can cause disruption at massive levels (Muhuddin et al., 2013; Niu et al., 2014). Consequently, threats to food security arise particularly in developing world where governments are already facing problem to fulfill ever increasing food demand of growing population and to meet the Sustainable Development Goal - 2 (SDG-2). Major challenge in achieving the target set in Paris agreement and SDGs arises in developing a governance framework that aligns SDG 2, 13, 14 and 15 with policies in agriculture and associated sectors (Ahmed et al., 2020; Pradhan & Belbase, 2018). Such governance framework requires involvement of multi-actors and multi-sectors (agriculture, livestock, fishery, land-use and water resource management) under changing climatic conditions and at different levels of governance to combat the impact of climate change. Unfortunately, a vast majority of agricultural economies are in developing phase where actors have inadequate technological, financial and human resource capacities to cope with ensuing challenges (Brown et al., 2010).

Policies designed in response to climate vulnerabilities focus on modern climate smart agriculture practices based on “triple-win” approach. Modern farming offer solutions based on “climate-smart agriculture (CSA)” practices that sustainably increase the agriculture productivity while ensuring resilience to climate change and reducing greenhouse gases (Tompkins et al., 2013). Climate-smart agriculture tries to transform agriculture system through coordinated actions by actors including farmers, institutions, researchers and agriculture extension workers. CSA operates through four action pathways: i) finding evidence, ii) improving institutional effectiveness, iii) coherence between agriculture and climate policies, and iv) integrating climate and agriculture financing (Lipper et al., 2014). Thus, the CSA demands innovative solutions targeted to achieve low-carbon and climate compatible development and that will need innovative policies, financing and enhancing actors’ capacity and establishing new institution for adaptation and greenhouse gas mitigation from agriculture sector (Shakya et al., 2018; Totin et al., 2018).

Agriculture sector covers 38% of the world’s area and utilizes 70% of the Earth’s fresh water (Muhuddin et al., 2013) and is the second largest contributor (24%) to global greenhouse gas emissions mostly from (cultivation of crops and livestock) and deforestation (Ritchie & Roser, 2020). Future strategies based on CSA try to meet the global commitment with interventions like on farm-level agricultural productivity, land-use regulations, farm-level water management, controlling pests, adjusting with market fluctuations, credits and insurance mechanism, technological innovation and extension (Amir et al., 2020b and Muhuddin et al., 2013). CSA practices inculcate both traditional as well as modern, tech-based agricultural solutions. In the past, these solutions were implemented through various climate adaptation projects but failed to achieve objectives. Among other reasons of failures, most commonly reported reason is lack of understanding of the complexity of institutions in which farmers and other actors in agriculture systems work (Totin et al., 2018). As a result, CSA practices now involve a gradual shift from solely relying on technological innovation to a system based approach encompassing full array of options including policies, market, technology, financing and institutional aspects.

Public institutions often referred as line departments are considered key actors as they play a significant role in CSA, for instance providing technical and financial support to farmers, updating information on cost-effective solutions, distribution of climate resistant seed varieties and providing guidance for on-farm water management (Khan et al., 2020). Institutional capacities refers to inherent characteristics of institutions that empower social actors to respond to short and long term impacts either through planned measures or encouraging creative responses from societies (Khan et al., 2020).

Government institutions play an important role in this context due to their well-established infrastructure and capacity to deliver free of cost solutions. Similar to other climate change interventions, CCD in agriculture sector should be supported by formal and informal institutions. However institutional capacities vary among different actors and at different level to implement such measures in terms of financial, technical, technological and human resources. Institutional capacities are manifested in the form of inherit and latent characteristics that empower actors to respond to climate changes (Huq, 2016). These characteristics include agency oriented capabilities such as skills, resources and access to technology. However, institutional capacity development is a continuous process, and needs to be assessed frequently for preparedness.

Like other developing countries, agriculture sector in Pakistan is at high risk due to climate change and its high vulnerability and low adaptive capacities (Fahad & Wang, 2018; Lohano & Mari, 2020). Pakistan chiefly relies on large contiguous irrigation channels derived from Indus Basin (Yu et al., 2013) which is mainly fed by glaciers in Himalaya and Karakoram ranges. Pakistan being the sixth most populous nation has escalating concerns about food security and is well aware of threats posed by climate change. A substantial body of literature exists on climate change impact on agriculture productivity in Pakistan and adaptation measures (Khan et al., 2020). Government of Pakistan has already framed 'Climate Change Policy, 2012' (GoP, 2012) and action plans (Ahmed et al., 2020) at federal and provincial levels, but still, the institutional framework is not adequately aligned to support these policies (Khan et al., 2020; Lohano & Mari, 2020; Mumtaz, 2018).

In this study, an effort has been made to develop a framework for assessing institutional capacity for modern smart agriculture in Pakistan for climate compatible development using a governance index approach with the objective to assess the actors' capacity against specific principles, criteria and indicators for climate response mechanism and implementation arrangements by taking the case of agriculture sector in Pakistan. The authors tried to answer the question whether capacity of the line departments involved in agriculture governance is adequate to achieve the targets of SDGs 2, 13, 14, and 15 for climate compatible development?

Methodology

Study design

The study is based on a criteria based index approach to assess the actors' capacity in agriculture sector for climate compatible development. For the purpose of present study, institutional framework based on line government departments' capacity was considered. The study is based on second principle of climate compatible development, which addresses climate competence, capacity and active role of the line government departments (CP2) as illustrated in Figure 1. Present study is part of an umbrella study aimed at developing governance indices for climate compatible development in Pakistan. Figure 1 thus illustrates the study framework adopted to develop governance indices.

The study employed a combination of 'Rules-based' and 'Rights-based' governance approaches along-with application of MCDA method on six components of the governance mechanism (Amer & Daim, 2011; Costa et al., 2017; Daim et al., 2009; Ishtiaque et al., 2019; McIntosh & Becker, 2020). The governance analysis model framework was developed after three consultation meetings with experts (Borgatti et al., 2009; Ingie Hovland, 2005; Wellman, 1983). The model was logically organized to address the issue of CCD based on principles, criteria and indicators. The model takes a generic approach by advancing the framework employed (Kartodihardjo et al., 2013) for participatory assessment of REDD+ governance in Indonesia.

Model is flexible, simple and easy to apply so that it can be used unabridged or in partial form for six different governance components separately using cross-sectional primary data. For this study, only second climate response principle (Table 1) was focused for developing governance index to assess the adequacy of actors' capacity in agriculture sector. Study approach adopted for the subset of innovative multivariate governance model for this study is portrayed in Figure 2. The analysis was carried out through a two-step procedure i.e., in the first step measuring tool was designed. In the second step, tool was applied for the determination of governance index for actors' capacity in agriculture sector in Pakistan.

Determination of key variables and primary data collection

The study is based on diverse sets of variables to develop governance model. By a careful downscaling procedure, the set of 58 composite indicators against nine CCD criteria, governance component 2 (GC2) i.e. actors' capacity (line government departments), CP2 and six (06) World Bank's good governance principles (Kartodihardjo et al., 2013) were used in the study, as illustrated in Figure 2. For the development of model, three consecutive consultative meetings with experts were organized in the Federal capital of Pakistan, Islamabad.

During meetings, scenario based learning and situational analysis technique (Dey, 2012; I. Hovland, 2005; Norris et al., 2012; Serrat, 2017) were employed using flip charts (Kartodihardjo et al., 2013) based on six components of governance with six criteria and good governance principles for the participatory assessment of REDD+ Governance. Present study thus provides additional scientific knowledge to the existing global pool by using nine criteria and six principles for CCD, which is unique, novel and not applied before on any CCD based study.

Table 1: Climate Response Principles and components of basic governance mechanism

Code	Climate Response Principle	Corresponding Governance Component
CP1	Respect climate policies, processes, strategies, law and the institution	Policy, legal and institutional arrangements (GC1)
CP2	**Ensure climate competence, capacity and active role of the line government departments**	**Role and capacities of the line government departments (GC2)**
CP3	Promote vibrant and influential role of the civil society stakeholders with climate competence and capacity	Role and capacities of CSOs & academia (GC3)
CP4	Maintain active engagement of the community based stakeholders towards climate endeavors	Role and capacities of Community based organizations (GC4)
CP5	Dynamic role of the private sector stakeholders for best climate solutions	Role and capacities of Corporate / private sector stakeholders (GC5)
CP6	Achieve and maintain participatory sustainable climate compatible performance	Practice and performance system (GC6)

Source: PhD dissertation of first author

MCDA's Simple Multi-attribute Rating Technique (SMART) (Edwards, 1977; Gärtner et al., 2008; Heinrich Blechinger & Shah, 2011; Leskinen & Kangas, 2005) was used with ratio scale (table 2) for scoring and weighting the criteria against the indicators.

Table 2: Ratio scale for scoring and weighting the criteria

Ratio Scale	Criteria
0	Not applicable or no response
0.01-1.99	Very poor
2.00-3.99	Poor
4.00-4.99	Considerable
5.00-5.99	Fair
6.00-7.49	Good
7.50-8.99	Very Good
9.00-10.00	Excellent

For weighting, normalization and validation of the composite indicators, a pilot exercise was carried out in Islamabad. A structured questionnaire cum scoring matrix was prepared with SMART ratio scale and by utilizing the applicable set of 58 composite indicators of agricultural governance for GC2. Sampling plan was designed keeping in view the geographical boundaries and size of the sample. Key informant interviews (KIIs) and focus group discussion (FGD) sessions were conducted using questionnaire at federal capital, provincial headquarters, and ten (10) districts (Swat, Mansehra, Bahawalpur, Rajanpur, Sanghar, Badin, Jhal-Magsi, Khuzdar, Muzaffarabad and Ghizer). The sampling locations were selected based on existing climate related projects and programmes by the government and other stakeholder groups including academia, civil society organizations and private sector. Thus, a purposive sample of 357 observations was taken, for which one Focus Group Discussion (FGD) and 20 Key Informant Interviews (KIIs) per sampling location were conducted.

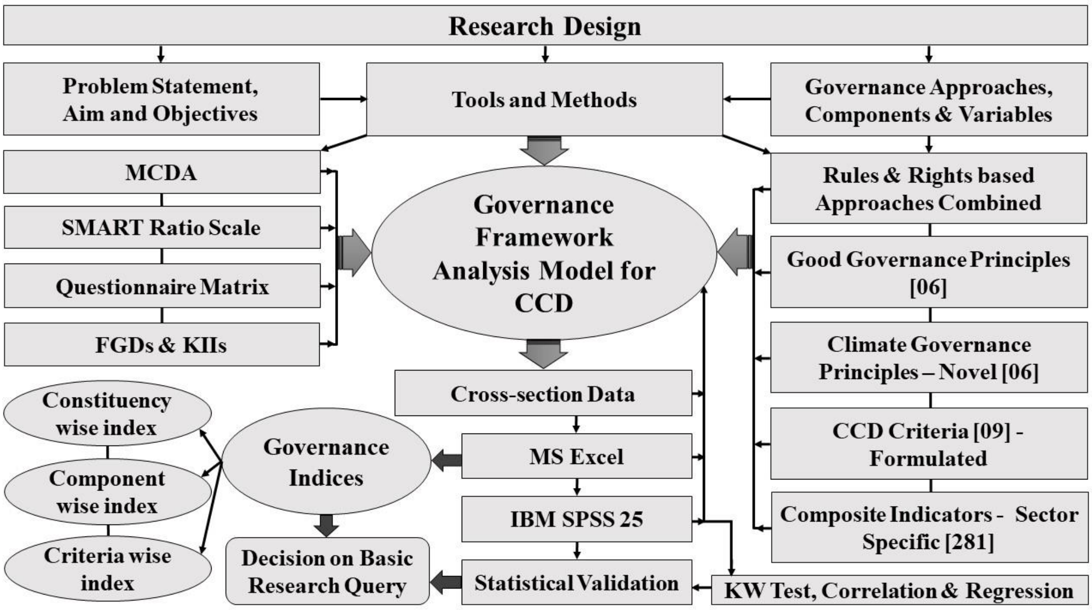

Figure 1. Study design and methodological steps' process flow (Source: PhD dissertation of first author)

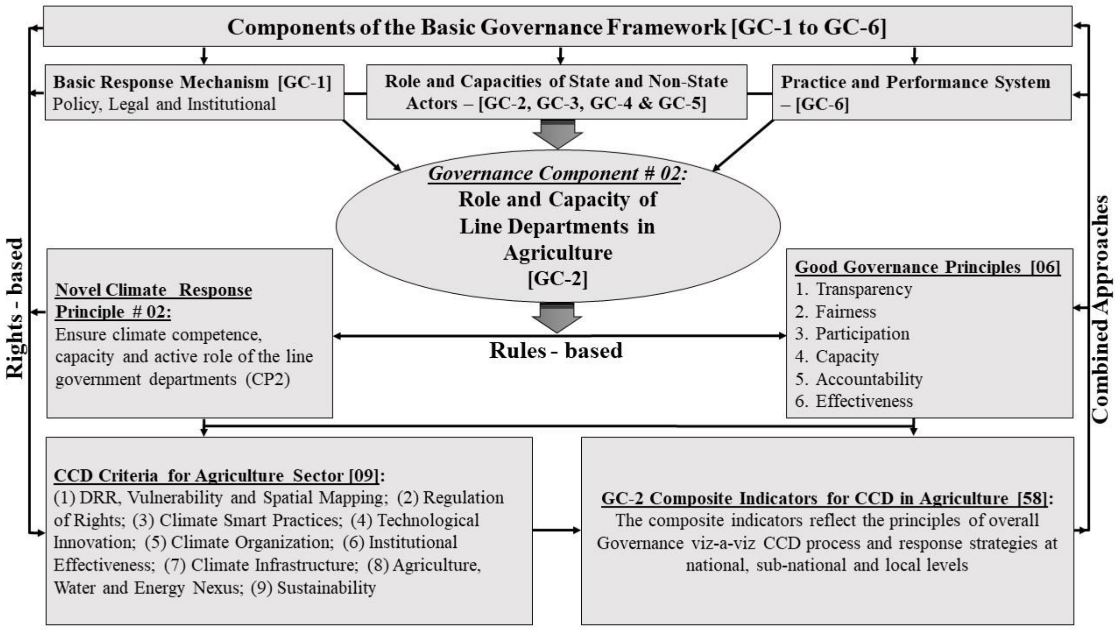

Figure 2: Multivariate Model of GC2 for CCD in Agriculture Governance (Source: PhD dissertation of first author)

Primary data management and analysis

Information collected through questionnaire was compiled, refined and processed using MS Excel 2016 for developing the governance index for GC2 in agriculture sector of Pakistan. Non-parametric Kruskal-Wallis (KW) hypothesis or H-test, Pearson Correlation and Regression using 'IBM SPSS Statistics 25' were used to validate the results. KW test was used to help in understanding and characterizing the sample groups with respect to variables constituency and gender to portray whether the samples are statistically dominating one way or the other, at federal, provincial and districts levels. The test helped in authenticating the originality of the sample data with the existence of diverse trends on a ratio scale. 1-tailed Pearson correlation analysis helped in developing further understanding about the relationship, impact and interlocking of different governance variables on each other, to have more clarity on complex interdependence for line government departments' capacity vis-à-vis CCD agenda in agriculture sector. The third test i.e. Multivariate Linear Regression analysis helped in analyzing the statistical association between different interlocking variables in order to decipher the research query.

Results

Table 3 shows criteria wise GC2 index for CCD response in agriculture sector of Pakistan. Figure 3 provides a graphical overview of governance index vis-à-vis nine criteria of CCD. Figure 4 shows criteria wise GC2 Index on a clustered bar chart, figure 5 forms a radar for the distances against governance index and figure 6 shows overall index for CCD Response at federal and provincial levels. Figure 7 shows GC2 index at districts level. Overall results depict AC-1.2 index scores 8.11, 4.86 and 3.43 with an average score 5.47; AC-2.2 index scores 4.66, 3.39 and 2.47 with an average score 3.50; AC-3.2 index scores 8.00, 4.54 and 3.42 with an average score 5.32; AC-4.2 index scores 7.45, 4.46 and 3.42 with an average score 5.11; AC-5.2 index scores 7.49, 4.41 and 3.45 with an average score 5.12; AC-6.2 index scores 8.55, 4.80 and 3.42 with an average score 5.59; AC-7.2 index scores 7.53, 4.25 and 3.42 with an average score 5.06; AC-8.2 index scores 6.96, 4.25 and 3.40 with an average score 4.87; AC-9.2 index scores 4.43, 3.07 and 2.10 with an average score 3.20; and constituency wise average scores 7.02, 4.23 and 3.17 at federal, provinces and districts levels respectively. The overall GC2 index score is 4.80.

Regarding statistical validation, Table 4 and 5 provide summaries of constituency and gender based KW Hypothesis Tests respectively for overall sample of GC2 in agriculture sector, for which asymptotic significances are displayed with their respective significance level of 0.05 (against N = 357); where null hypothesis is rejected for all the cases. It authenticates the observations and depicts different responses from all respondents at federal, provincial and district levels. Pearson correlations with significance at the 0.01 level (1-tailed) are shown in Table 6 and figure 8 that indicate a very strong correlation among all CCD criteria of the governance under GC2. Whereas; descriptive statistics of multivariate Regression analysis for overall sample of agriculture sector are shown in Tables 7 to 10 while Figure 9 shows normal P-P Plot and Figure 10 shows scatter plot of Regression standardized residual for overall sample in agriculture sector. AC-9.2 i.e. sustainability of GC2 was used as dependent variable. The values of R and R Square are 0.939 and 0.882 respectively. Coefficients of T-test show significant relationship of AC-9.2 with AC-2.2, AC-4.2, AC-7.2 and AC-8.2 (with values above ±2); except all other criteria. However, collinearity diagnostics i.e. tolerance below 0.10 and VIF above 10 creating interference for all these relationships thus don't support their significance; despite all criteria have shown a very good zero-order correlations with AC-9.2. The normal P-P plot shows very good result with very low level of deviations to upward and downward fluctuations and the scatter plot shows 3 different groups out of which two groups are submerged to each other, but overall it is showing very good results within the ±3 boundaries. Although majority of the criteria in GC2 index of the governance are impacting each-other, as a whole the null hypothesis of the basic research question can't be rejected for the case of GC2. So, GC2 results also indicate so far the absence of a proactive and inclusive response mechanism to govern climate compatible development in agriculture sector at federal, provincial and districts levels in Pakistan for its environmental security.

Table 3: GC-2 Index for CCD Response in Agriculture Sector

	Criteria wise Index Score			
CCD Criteria	**Federal**	**Provinces**	**Districts**	**Average**
Disaster Risk Reduction, Vulnerability and Spatial Mapping (AC-1.2)	8.11	4.86	3.43	5.47
Regulation of Rights (AC-2.2)	4.66	3.39	2.47	3.50
Climate Smart Practices (AC-3.2)	8.00	4.54	3.42	5.32
Technological Innovation (AC-4.2)	7.45	4.46	3.42	5.11
Climate Organization (AC-5.2)	7.49	4.41	3.45	5.12
Institutional Effectiveness (AC-6.2)	8.55	4.80	3.42	5.59
Climate Infrastructure (AC-7.2)	7.53	4.25	3.42	5.06
Agriculture, Water and Energy Nexus (AC-8.2)	6.96	4.25	3.40	4.87
Sustainability (AC-9.2)	4.43	3.07	2.10	3.20
Overall Average	**7.02**	**4.23**	**3.17**	**4.80**

[**Scale:** 0 = Not applicable or no response yet, 0.01 to 1.99 = Very Poor, 2.00 to 3.99 = Poor, 4.00 to 4.99 = Considerable, 5.00 to 5.99 = Fair, 6.00 to 7.49 = Good, 7.50 to 8.99 = Very Good, 9.00 to 10.0 = Excellent]

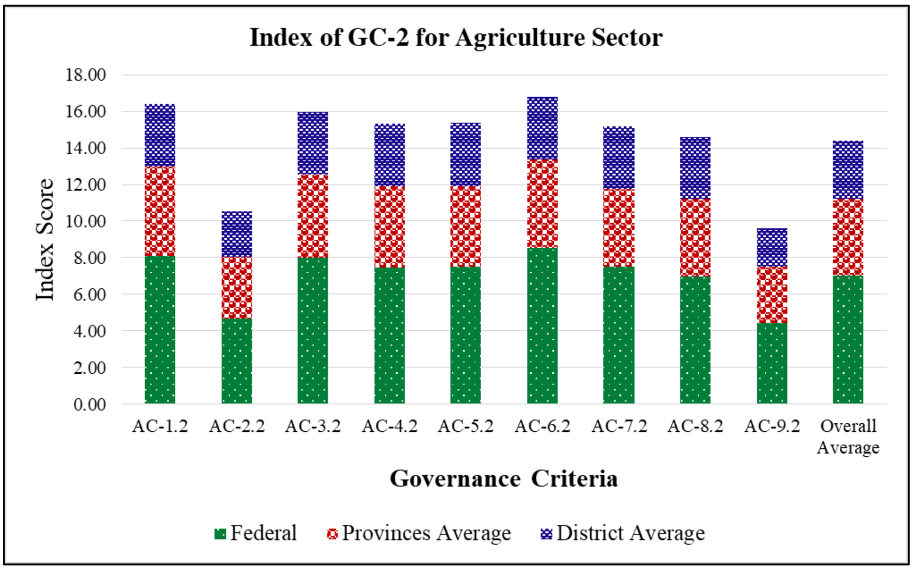

Figure 3: Criteria wise GC-2 Index for CCD Response in Agriculture Sector

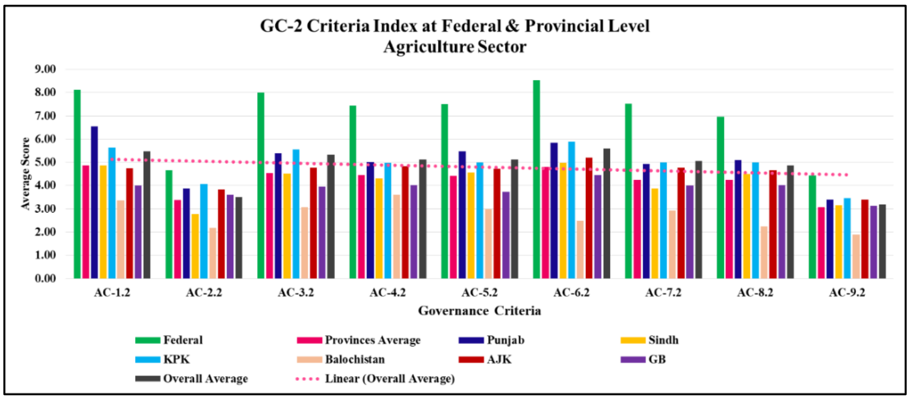

Figure 4: Criteria wise GC-2 Index for CCD Response at Federal & Province Level

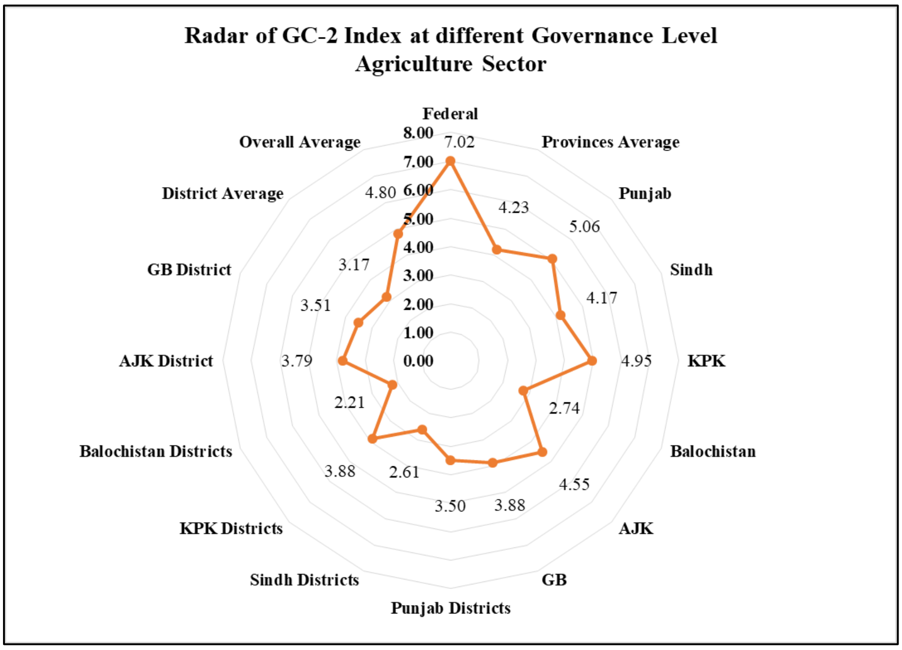

Figure 5: GC-2 Index Radar for CCD Response at different Governance Level in Agriculture

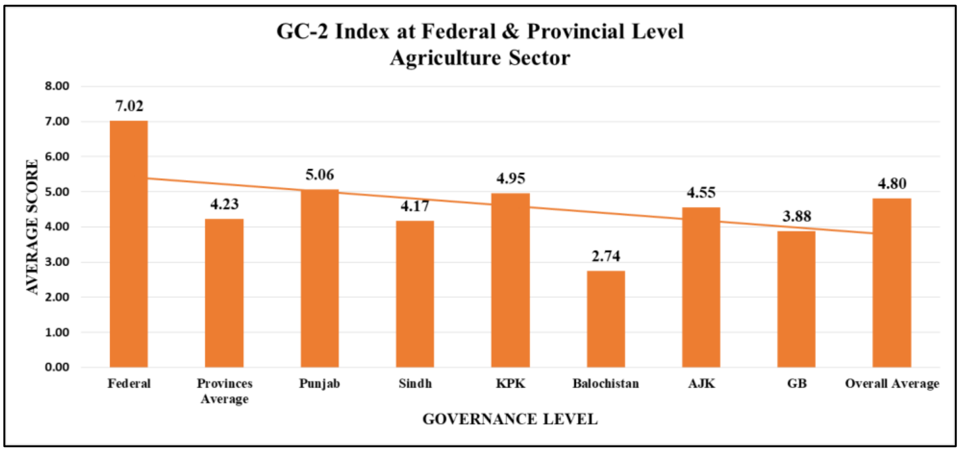

Figure 6: GC-2 Index for CCD Response at Federal & Provincial Level in Agriculture Sector

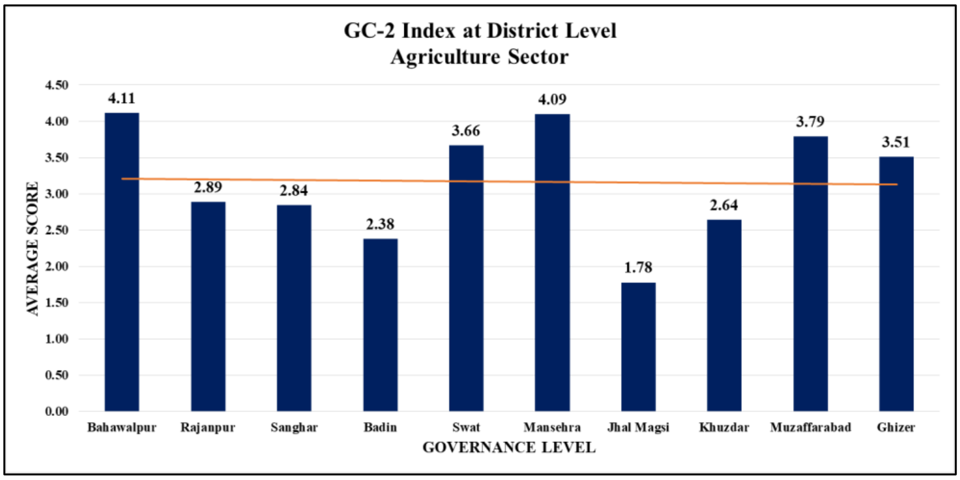

Figure 7: GC-2 Index for CCD Response at District Level in Agriculture Sector

Table 4: Summary of Constituency based KW Test for GC-2 sample in Agriculture Sector

Hypothesis Test Summary				
	Null Hypothesis	**Test**	**Sig.**	**Decision**
1	The distribution of DRR, Vulnerability and Spatial Mapping is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of Regulation of Rights is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of Climate Smart Practices is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
4	The distribution of Technological Innovation is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
5	The distribution of Climate Organization is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
6	The distribution of Institutional Effectiveness is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
7	The distribution of Climate Infrastructure is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
8	The distribution of Agriculture, Water and Energy Nexus is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
9	The distribution of Sustainability is the same across categories of Constituency.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .05. N = 357				

Table 5: Summary of Gender based KW Test for GC-2 sample in Agriculture Sector

Hypothesis Test Summary				
	Null Hypothesis	**Test**	**Sig.**	**Decision**
1	The distribution of DRR, Vulnerability and Spatial Mapping is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of Regulation of Rights is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
3	The distribution of Climate Smart Practices is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
4	The distribution of Technological Innovation is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
5	The distribution of Climate Organization is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
6	The distribution of Institutional Effectiveness is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
7	The distribution of Climate Infrastructure is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
8	The distribution of Agriculture, Water and Energy Nexus is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
9	The distribution of Sustainability is the same across categories of Gender.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
Asymptotic significances are displayed. The significance level is .05. N = 357				

Table 6: Summary of Correlations between CCD Criteria for GC-2 in Agriculture Sector

Pearson Correlations									
CCD Criteria	**AC1.2**	**AC2.2**	**AC3.2**	**AC4.2**	**AC5.2**	**AC6.2**	**AC7.2**	**AC8.2**	**AC9.2**
AC1.2	1								
AC2.2	.824**	1							
AC3.2	.961**	.839**	1						
AC4.2	.946**	.835**	.964**	1					
AC5.2	.957**	.835**	.967**	.955**	1				
AC6.2	.960**	.856**	.974**	.952**	.961**	1			
AC7.2	.938**	.846**	.970**	.968**	.960**	.960**	1		
AC8.2	.931**	.836**	.946**	.931**	.950**	.961**	.951**	1	
AC9.2	.871**	.902**	.882**	.877**	.882**	.897**	.872**	.886**	1
***. Correlation is significant at the 0.01 level (1-tailed).*									

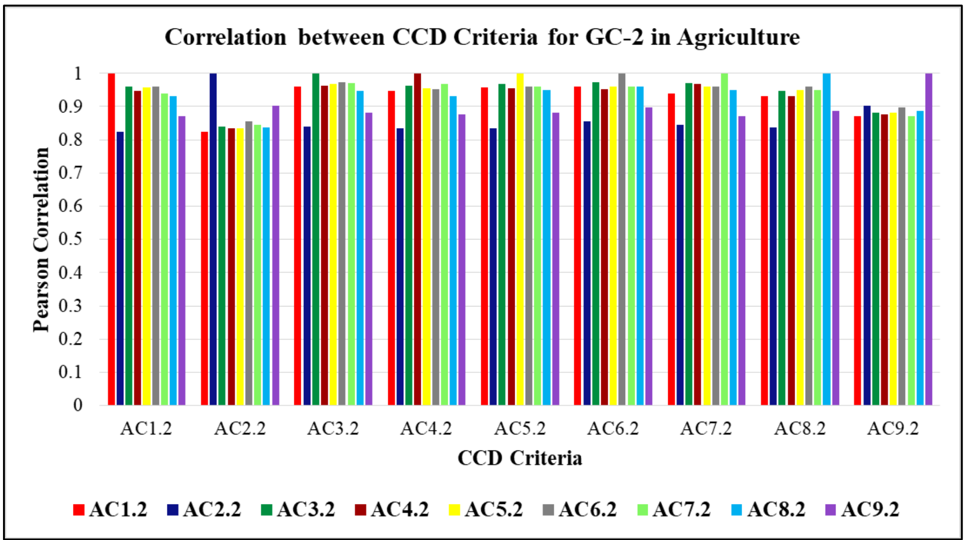

Figure 8: CCD Criteria wise Pearson Correlations for GC-2 in Agriculture Sector

Table 7: Regression Model Summary for GC-2 in Agriculture Sector

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.939[a]	.882	.879	.31528

a. Predictors: (Constant), Agriculture, Water and Energy Nexus, Regulation of Rights, DRR, Vulnerability and Spatial Mapping, Technological Innovation, Climate Organization, Climate Infrastructure, Institutional Effectiveness, Climate Smart Practices
b. Dependent Variable: Sustainability

Table 8: ANOVA Summary for GC-2 in Agriculture Sector

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	257.777	8	32.222	324.153	.000[b]
	Residual	34.593	348	.099		
	Total	292.370	356			

a. Dependent Variable: Sustainability
b. Predictors: (Constant), Agriculture, Water and Energy Nexus, Regulation of Rights, DRR, Vulnerability and Spatial Mapping, Technological Innovation, Climate Organization, Climate Infrastructure, Institutional Effectiveness, Climate Smart Practices

Table 9: Summary of Regression Coefficients for GC-2 in Agriculture Sector

Coefficients[a]									
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations Zero-order	Collinearity Statistics	
		B	Std. Error	Beta				Tolerance	VIF
1	(Constant)	-0.222	0.075		-2.947	0.003			
	DRR, Vulnerability and Spatial Mapping	-0.002	0.048	-0.004	-0.047	0.962	0.871	0.056	18.005
	Regulation of Rights	0.501	0.036	0.498	13.727	0	0.902	0.258	3.878
	Climate Smart Practices	0.049	0.072	0.075	0.683	0.495	0.882	0.029	35.085
	Technological Innovation	0.158	0.063	0.212	2.521	0.012	0.877	0.048	20.721
	Climate Organization	0.089	0.063	0.124	1.416	0.158	0.882	0.044	22.684
	Institutional Effectiveness	0.084	0.06	0.147	1.402	0.162	0.897	0.031	32.262
	Climate Infrastructure	-0.244	0.071	-0.336	-3.429	0.001	0.872	0.035	28.222
	Agriculture, Water and Energy Nexus	0.195	0.055	0.266	3.58	0	0.886	0.062	16.21

a. Dependent Variable: Sustainability

Table 10: Regression's Residual Statistics for GC-2 in Agriculture Sector

Residuals Statistics[a]					
	Minimum	Maximum	Mean	SD	N
Predicted Value	.8186	4.8306	2.5768	.85094	357
Residual	-.84340	.85766	.00000	.31172	357
Std. Predicted Value	-2.066	2.649	.000	1.000	357
Std. Residual	-2.675	2.720	.000	.989	357

a. Dependent Variable: Sustainability

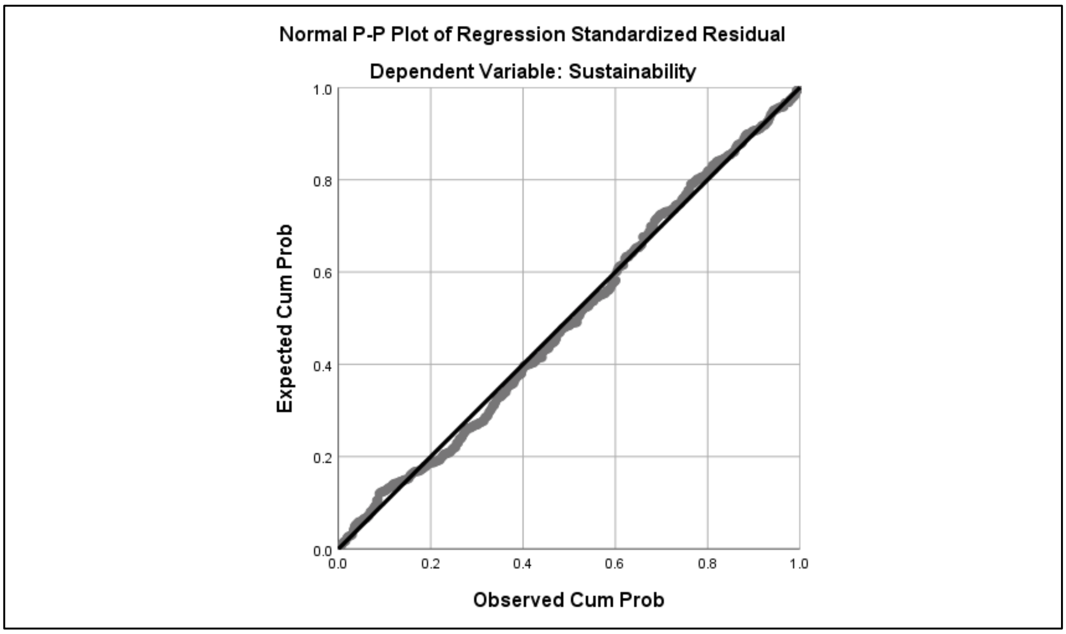

Figure 9: Normal P-P Plot of Regression Standardized Residual for GC-2 in Agriculture Sector

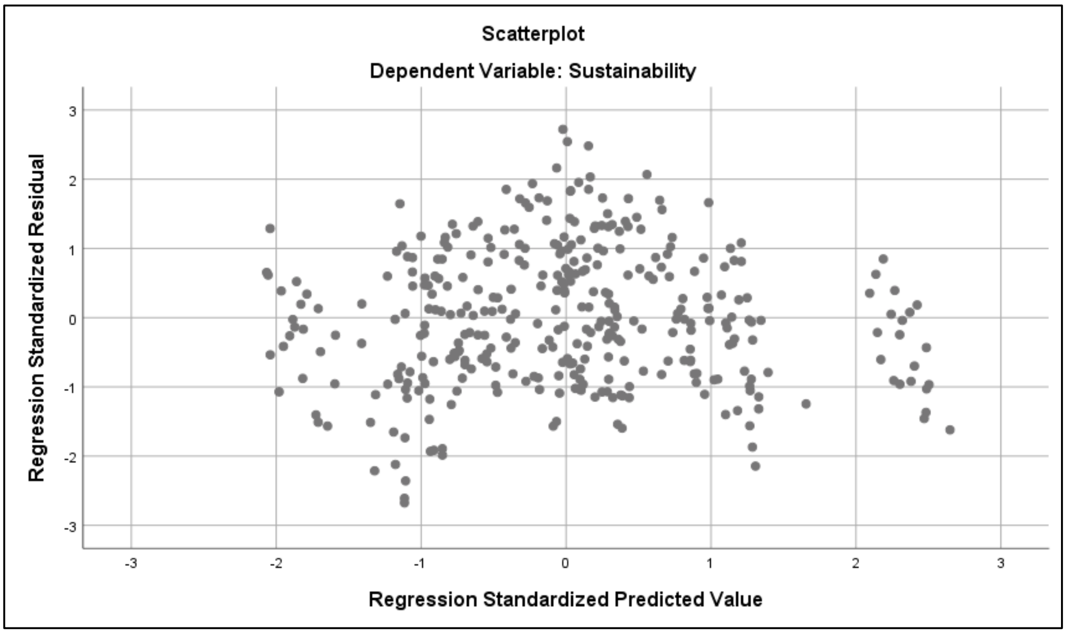

Figure 10: Scatter Plot of Regression Standardized Residual for GC-2 in Agriculture Sector

Discussion

Public institutions are considered key stakeholders particularly in irrigated agriculture for their role in providing different services. However, agriculture sector depends on a mix of public, private and community institutions for providing different services like irrigation, on-farm water management, pest control, land use zoning, credit and insurance, market control and distribution of seeds (Amir et al., 2020b; Khan et al., 2020). The services provided to farmers can be classified into two types; first category deals with the farmer's access to financial resources including credits, loans, grants funds etc., while, the other category of the services deals with access to knowledge and technology for climate smart practices (Abid et al., 2017).

Pakistan responded to climate change realizing its sensitivities and vulnerabilities for agriculture sector. In response, first national climate change policy was launched in 2012 followed by action plan. National

Climate Change Policy of Pakistan proposed 120 policy measures involving multiple sectors (GoP, 2012; Mumtaz, 2018). Among other sectors, the policy also focused on assessing mitigation options and vulnerabilities and implementing measures for climate adaptation and resilience in agriculture sector. The policy describes resilient and climate compatible agriculture as system based on modern and CSA practices to address new opportunities and threats from climate change. Such a system will require suitable infrastructure at farm level, technological innovations, spatial mapping and land use zoning, well planned response mechanism, disaster preparedness and funds (Lohano & Mari, 2020). CCD in agriculture sector is complex due to the involvement of multiple actors belonging to formal and informal institutions and various sectors.

Therefore, in order to achieve climate compatible development in agriculture sector, assessment of actors' capacity is crucial for effective planning and implementation. Present study thus tried to develop governance index for capacity of line departments to implement projects aiming at modern climate smart agriculture against nine criteria and 58 indicators as mentioned in table 3. Previously, study conducted by Khan et al., (2020) also developed institutional capacity indices based on seven indicators to assess institutional capacities for climate change adaptation and risk management in agriculture sector.

Governance index score calculated on the basis of KIIs and FGDs revealed that under GC2, the capacity to meet the goals of CCD of the line departments is good at federal level (7.02) while it is considerable at provinces (4.23) but poor at districts level (3.17), reflecting a weak overall capacity (Average overall governance index score = 4.80) to meet the climate change challenges (Hussain et al., 2020; Mumtaz, 2018). The findings corroborate with the fact that agriculture remained a federal subject till 2010. After 18th Amendment in the 1973 Constitutions of Pakistan, rights to regulate in agriculture sectors were transferred to provinces but food security became federal subject after establishment of Ministry of Food Security at federal level. However, the devolution process where provided autonomy to the provinces, also created ambiguity regarding rights to regulate. In this context, Bell et al., (2013) argued that institutions have weak perception about role of irrigation management in water governance framework. The lowest index score (3.50) against *CCD criteria 2- regulation of rights* also substantiates the argument by Bell et al., (2013). A similar notion can be inferred from lowest score against all nine criteria at district level. The findings are reflective of a lagging phase of devolution where rights are transferred from federal to provinces but further trickling is yet not achieved.

Inadequate capacities at local level institution have a negative impact on the sustainability (over average index score = 3.20) and overall performance of the institutions (over average index score = 5.59) working at provincial and federal level too. Low governance index score (3.20) against criteria nine (Sustainability) reflects the negative impact on the sustainability of the initiatives taken for introducing climate smart practices. Focus group discussions pointed out that many interventions taken in agriculture sectors were project based and could not sustain after projects due to lack of ownership and inadequate capacities. Governance index score for the Criteria 9-Sustainability also supports the findings of the FGD. Similar findings were reported by (Chaudhury et al., 2016) with reference to failure of Local Adaptation Plan For Action (LAPA) projects. The project was initiated with a funding of USD 0.72 million with aim to develop solutions for low cost adaptation and resilient interventions in southern districts mostly affected by floods and droughts. Project was designed in consultation with union councils and community based organizations, however, (Chaudhury et al., 2016) apprehended regarding difficulty in scaling up of this project due to lack of legitimacy and ownership by provincial and national departments.

Access to different institutional services could play an important role in improving farmers' resilience to cope with climatic hazards at the farm and household levels. For example, better institutional access can prepare farmers to adjust their cropping practices according to climatic patterns, facilitate use of technologies and new plant varieties, and provide them with credits to protect their livelihood (Abid et al., 2017). Poor governance index score against criteria 1-9 at districts levels reflect inadequate capacities of local institutions to implement climate smart practices. Studies carried out at farmers' level also reported issues pertaining to climate related hazards reflecting inadequate capacities of local institutions to fulfill the requirements of farmers. Among other problems reported, insecure land tenure, lack of market access, water availability, lack of access to assets and credits, climatic extremes and resultant loss in agriculture productivity, lack of knowledge, information about modern climate smart agriculture practices are common issues (Khan et al., 2020; Muhammad et al., 2012).

Significant progress has been made since United Nation Framework Convention on Climate Change – 1992 and Rio Earth Summit – 1992 in exploring the science of climate change, developing human-climate linkages and finding out ways to control pollution and adaption measures. This would not have been possible until the strategies agreed at global level were not owned locally. In the present scenario, developing countries have greater responsibilities of developing national and local adaptation strategies consonant with their local situations to tap the opportunities available through Global Climate Change Fund (Chaudhury et al., 2016) Like the rest of the world, the situation demands for the development of required climate infrastructure, capacity building of institutions, climate organizations and clarity regarding role and responsibilities of the actors at provincial and district levels. Therefore, there is a need to enhance the capacities of the provincial line departments along-with mainstreaming their district arms.

Conclusion

Pakistan's high vulnerability to climate-induced anomalies in agriculture sector requires that line-departments must be capable enough for effective management of climate change risks and to facilitate climate smart agriculture practices at farm level. But capacity mapping of line-departments for climate compatible development as determined through governance index approach employing nine criteria at federal, provincial and district levels in this study indicates that line departments at federal level are better equipped than the provincial and district departments, to face the challenges posed by climatic threats. In general, institutions also lack capacity in terms of human, financial, technical and technological resources to respond to emerging challenges with adequate measures. Moreover, vertical and horizontal coordination among actors at various levels among different sectors is also a missing link.

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