IJIST
ISSN : 2618-1630

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VOLUME 1 ISSUE 3

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International Journal of Innovations in Science and Technology

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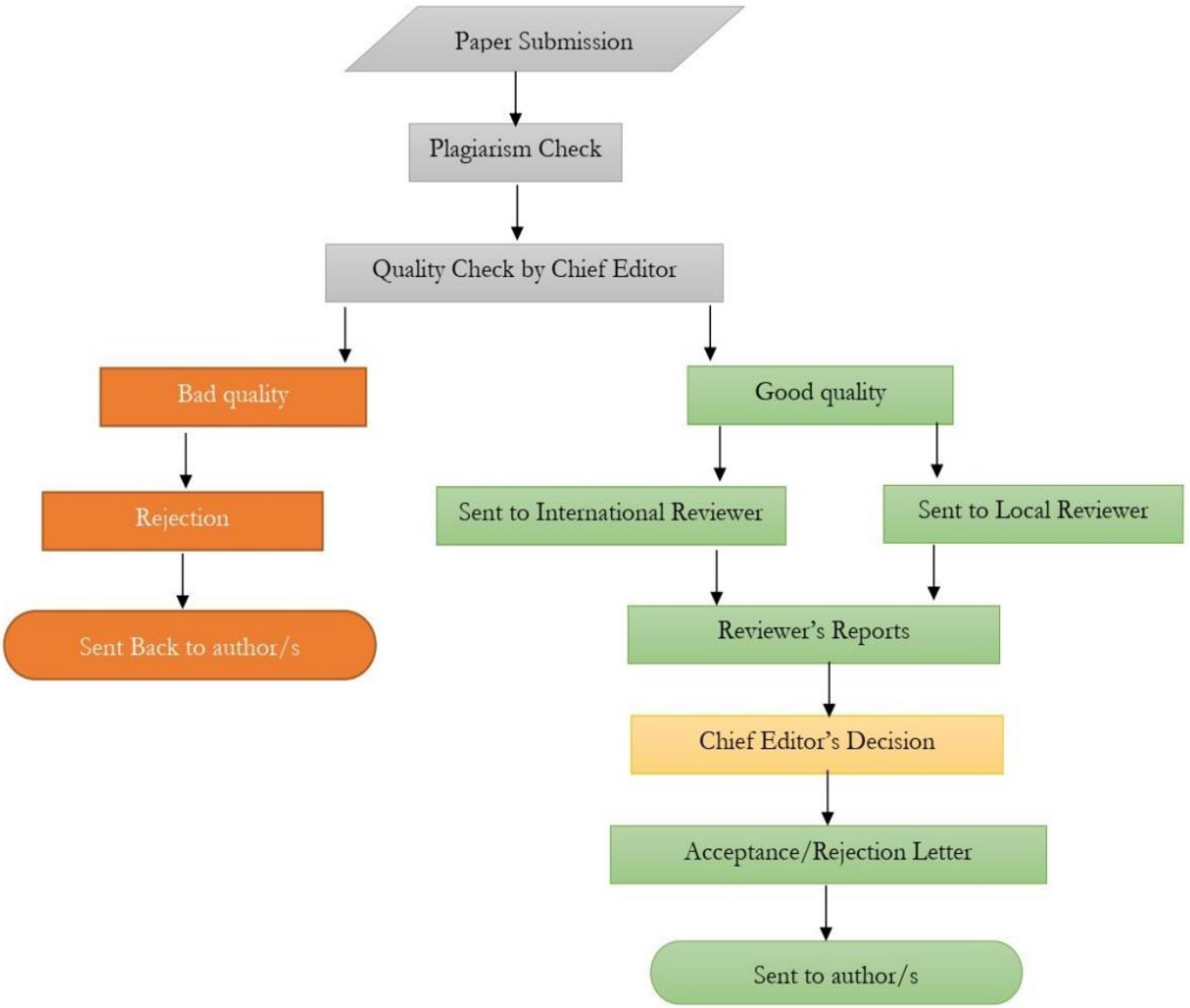

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International Journal of Innovations in Science & Technology (IJIST)

ISSN 2618-1630

V1-I3 | September 2019

ISSN : 2618-1630

Role of Inter-Organizational Information Integration in successful E-Governance

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Citation | Afzaal.H.M and Masood.M,". Role of Inter-Organizational Information Integration in successful E-Governance. International Journal of Innovations in Science & Technology, Vol 01 Issue 03: pp 89-107, 2019.
DOI | https://doi.org/10.33411/IJIST/2019010307
Received | May 17, 2019; Revised |June 15, 2019 Accepted | June 16, 2019; Published | June 17, 2019.

Abstract. The global emerging trends of E-Governance utilizes Information and Communication Technologies (ICTs) to support the governance functions. It emphases on improving governance by innovating administrative processes, transforming relationships, improving public services delivery, ensuring accountability, increasing participation and collaboration among civil society, government and private sector. Whereas, E-Governance is considered a revolutionary reform of promoting good governance through greater control over state power, authority and resources to promote equality, peace and prosperity by eliminating corruption, unemployment and hunger. Pakistan had made huge investments on deploying ICTs infrastructure and human resource development in public sector but the country could not achieve the expected outcomes. The results show that public sector has adequate level of ICTs infrastructure and competent human resource to obtain the promising benefits of these initiatives. However, all these resources remained underutilized which is considered a public sector dilemma in Pakistan. Most of public sector businesses are still relying on the manual systems rather than the fully computerized or automated and the public officials are bound to exchange and processes information manually. The under-utilization of these technologies and human resource cannot reap the benefits of E-Governance and therefore could not promote transparency, accountability, equality, and participation for sustainable socio-economic growth and development of Pakistan.

Keywords: E-Governance; E-Services; Inter-Organizational Information Integration and Public Sector Performance.

Introduction.

The world has noticed a digital revolution in the early 1990s, which has provided new means of interaction, collaboration and communication among individuals, organizations and societies around the world. Governments are empowering the masses through Information and Communication Technologies (ICTs) to overcome multilevel and multifaceted local as well as global challenges. The utilization of ICTs for the provision of public services under the framework of E-Governance had become essential for growth and development in the contemporary world. Whereas, the idea of E-Governance concentrated immense significance, globally, as a revolutionary trend and emerging practice of facilitating stakeholders across the territorial boundaries. The global phenomenon of E-Governance adoption became a prominent strategy for government administrative reforms [1,2,3,4,5,6].

The world has noticed a digital revolution in the early 1990s, which has provided new means of interaction, collaboration and communication among individuals, organizations and societies around the world. Governments are empowering the masses through Information and Communication Technologies (ICTs) to overcome multilevel and multifaceted local as well as global challenges. The utilization of ICTs for the provision of public services under the framework of E-Governance had become essential for growth and development in the contemporary world. Whereas, the idea of E-Governance concentrated immense significance, globally, as a revolutionary trend and emerging practice of facilitating stakeholders across the territorial boundaries. The global phenomenon of E-Governance adoption became a prominent strategy for government administrative reforms [7,8,9,10,11,12].

Whereas, the developed countries had acquired cutting-edge technologies and technical expertise required to achieve their innovation objectives. However, the developing economies are struggling to reform their public sector and reinvent the government through utilizing ICTs under the E-Governance framework. They had introduced numerous E-Government programs to improve public services delivery and to insure effectiveness, efficiency, accuracy, transparency and reliability. While, the deployment of ICTs in public sector under the E-Governance agenda is also considered significant in order to materialize the Good Governance [13,14,15,16,11,17].

However, there are three main dimensions of e-governance: 1) improving government processes through "*e-administration*", 2) connecting citizens through "*e-citizens* and *e-services*" and 3) developing external linkages through "*e-society*". E-Governance is considered a finest approach used by the governments to interact, engage and collaborate with stakeholders in an innovative and sophisticated ways and with greater efficiency, accuracy, transparency and reliability. E-Governance has shown encouraging results in developed countries for achieving sustainable growth and development [10].

Whereas, the absence of e-communication, e-collaboration and e-integration at intra-organizational and inter-organizational level, are the basic challenges confronting to public sector organizations in many countries which are identified as the most critical success factor of E-Governance. While, many researches authenticates that without the proper electronic Inter-Organizational Information Integration, efficiency in delivering public services to all stakeholders is not feasible. Furthermore, just moving from manual to computerized systems or providing information online are not sufficient and therefore considered the underutilization of available resources which is self-destructive in actualizing the expected outcomes [18,19 20].

The basic idea of Inter-Organizational Information Integration is to enhance the scope of E-Governance by utilizing the most advance ICTs infrastructure and proficient human resource. The main objective of Inter-Organizational Information Integration is to improve the quality of public services and processes. The framework of Inter-Organizational Information Integration requires a "Central Information Storage Unit" which connects all the government departments or division to make the tedious and complex work of processing and sharing information easy, efficient and reliable without the time and space limitations. While, the popularity of E-Governance has increased the pressure on government departments to improve and enhance interaction, communication and collaboration for improving the performance of governments. Whereas, the Inter-Organizational Information Integration promotes interaction, communication and collaboration among different government bodies in order to ensure efficiency, accuracy, transparency, reliability and cost effectiveness [21,22,23,24,25,26].

The current challenges of big data management necessitate the transformation of work places and reorganization work processes through utilizing Information Systems which is the most critical success factor of contemporary society. It is challenging to harness the potential of Information Systems to realize the outcomes of E-Governance initiatives. However, when these projects fail, the economy(ies) suffer through sever crisis and numerous socio-economic evils emerges [27,28,29,30,31].

E-Governance is not only about the computerization of the existing government processes or the digitalization of official documents [4, 27], but it aims harness optimum capacity these technologies, such as integration. However, there is no common understanding of converting manual system to fully or partially computerized system, but one thing is endorsed from the different studies and experiences of other countries is that the integration between departments in necessary which ensures real time interactions, communication, collaboration and accessibility [26, 28].

There is no common understanding that manual system should be fully converted or partly to the computerized system, but one thing is endorsed from the different studies and experiences for achieving maximum efficiency and effectiveness the integration between departments in necessary which ultimately and definitely ensures real time interactions and accessibility in delivering public services [34,31,35,36].

E-Governance and Information and Communication Technologies

ICTs are playing a crucial role in the sustainable development efforts around the world and considered essential for modernizing economies. It improves the economic growth, production, distribution, consumption, resources allocation, national and international trade. It is also necessary for improving public service delivery and public administration. ICTs has potential to reduce poverty and unemployment and to meet good governance goals in the developing countries [7,37].

Whereas, the idea of using ICTs by the governments in public services delivery was emerged during 1950s and the Information Systems (IS) were developed to incorporate into business organizations. While, ICTs and IS rapidly spread after the emergence of World Wide Web in the early 1990s and form the basis of E-Governance [38,5].

E-Governance and E-Government

The concept of E-Government was introduced in the United Nations General Assembly in 2000 on the adoption of Millennium Development Goals, which set out a future vision to harness the potential benefits of new technologies, especially ICTs and affirmed the availability for all [2]. Whereas, the term E-Government is applied both to the field of practice and to the domain of study. E-Government is a plan of action as well as a field of study to explore the usage of ICTs and IS to support public policies, government operations, engage citizens and provide government services [39]. E-Government aims at ensuring that all government information must be available online for everyone to enhance accountability and transparency in order to minimize corruption in the public sector [36].

However, the term E-Governance evolved in the recent decade and often used as a substitute of E-Government. Although, the concept of E-Governance and the difference between E-Governance and E-Government is highly debatable but both involves ICTs to deliver public services. E-Governance has extensively wider scope and deals with controlling power and authority, constitution and policy making, defining the roles of actors, reforming the public administration, improving transparency and accountability, reducing corruption and violence, and transforming political, economic and socio-cultural practices [8, 13, 22].

E-Government is transforming the ways to, shares information, and to delivers services to different stakeholders. It aims at harness the potential of ICTs to improve relationships with citizens, businessmen, and among different government bodies. E-Government initiatives should be the part of broader reforms to improve public sector performance [2]. The transformation towards E-Governance requires the revitalizing public sector by imparting the public service ethics and the values of welfare society. It requires greater equality, inclusiveness, participation and engagement of citizens in policy making process and public service delivery for increasing productivity transparency and accountability [14].

E-Governance and Inter-Organizational Information Integration

The inter-organizational information integration deals with the exchange of information across organizations, at different levels and also with other stakeholders in the shortest period of time with minimum cost besides the accuracy, reliability and accessibility. [3,40,20]. The Integration is a critical success factor for achieving a mature level of E-Governance. Previous researchers have identified that the inter-organizational information integration is one of the most advanced level of E-Governance which is not simply a technical matter for sharing information within and between the government departments but there is need of an innovative organizational policy, strategic planning and legal technical and framework [13]. However, the integration of information across organizational boundaries demands greater understanding of this phenomenon [14,39].

The absence of Inter-Organizational Information Integration can cause inefficient and ineffective public sector performance, which slower the economic growth and leads to socio-cultural backwardness, economic fluctuations and inefficient resource allocation, loss of public trust, misuse of authority and increase corruption, crime and violence in the society. The failure

of integration leads to high costs, inefficiency and inaccuracy meanwhile the loss of huge investments on ICTs and IS. However, E-Governance initiatives are lagging far behind users' expectations in developing economies [39,41].

Unlike public sector, the private sector has strongly embraced these ideas of utilization of ICTs in business and develop E-Commerce, E-Services, and E-Banking. Now citizens and businesses are demanding efficiency, accuracy, transparency, reliability and effectiveness of public sector services [4,20]. In the said circumstances it will be very difficult and nearly impossible to deliver public services effectively and efficiently [16,6].

Material and Methods.

Investigation site.

University of the Punjab is one of the most distinguished public sector university in Pakistan which has extensively deployed ICTs infrastructure and develop proficient human resource in all departments including administration. The university had largest IT Network, Web sites and Software development center, Services Management System (SMS) and also acquired oracle-based Campus Management System (CMS).

Methods.

The study has used survey research design and a structured questionnaire, comprising 40 closed ended questions which were developed for data collection. The data was coded and entered into SPSS 23rd version prior to data analysis that applied different statistical tests such as frequency analysis, Pearson's correlation and multinomial logistic regression.

The data was collected from the network administrators working in all different departments of Punjab University. The network administrators were selected over their job responsibilities of managing technological issues in departments including the proper functioning of computers, printers, scanners, projectors, LCDs, internet, Wi-Fi routers, CCTVs and internal and external communication networks.

Result and discussion.

The data shows the modes of services provided by the public sector, demand for different modes of services and preferences of officials. The data also unveil the literacy level including digital literacy of public officials and skills, knowledge and abilities of public officials. It also provides information about the available ICTs infrastructure, capacity of available ICTs infrastructure, and utilization of available ICTs infrastructure in public sector organizations.

Table 1. Modes of Public Services and Administrative Practices

	Present Practices		Officials' Preference		Stakeholders' Demand	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Fully Computerized	3	3.5	78	91.8	70	82.4
Fully Manual	1	1.2	1	1.2	1	1.2
Hybrid System	81	95.3	6	7.1	14	16.5
Total	85	100	85	100	85	100

Table 1 show the current operating mechanism of public sector organizations as well as the preferences and demands for different options. Statistics highlights that public-sector organizations neither have fully manual nor fully computerized but, hybrid system (95. 30%). While, most of the respondents (82.40% and 91.80%) show their strong preferences and demands respectively for fully computerized system in public sector organizations. However, it is evident that huge investment has been made on deploying ICTs in public sector organizations to adopt modern administrative practices under the E-Governance initiatives but these resources had never been utilized to their greatest potential.

Table 2. Present Practices for the Exchange of Data or Information

	Inter-Organizational Information Integration		Present Practices of Officials		Present Practices of Departments	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Fully Computerized	4	4.7	7	8.2	7	8.2
Fully Manual	1	1.2	7	8.2	9	10.6
Hybrid System	80	94.1	71	83.5	73	85.9
Total	85	100	85	100	85	100

In Table 2, the frequency analysis evaluates the present practices of exchanging data between officials and departments and highlights that most of the respondents favored Hybrid system (83.50%). Whereas, similar trends were found in the present practices of exchanging data between departments (85.90%) and Inter-Organizational Information Integration is also greatly dependent on hybrid system (80%). This trend shows the real reason behind the slow public sector performance in Pakistan. The aftermath of computerization and digitalization requires atomization and integration which is the most critical success factor of E-Governance.

Table 3. Demand and Preference of Information Integration

	Officials' Preferences		Stakeholders' Demand	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Fully Computerized	63	74.1	60	70.6
Fully Manual	0	0	0	0
Hybrid	22	25.9	25	29.4
Total	85	100	85	100

Table 3 is showing the respondents' favor for fully computerized system and the same trend was found in present practices of exchanging information between officials and departments (70.60%). However, according to Table 1 and 2, the departments and officials are more dependent on the hybrid system which is contrary to their demands and preferences.

Table 4. Competency, Digital Literacy and Motivation of Public Sector Officials

	Skills, Knowledge, Abilities		Digital Literacy		Motivation Level	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Strongly Agree	5	10.6	9	10.6	13	15.3
Agree	59	69.4	51	60	16	18.8
Neutral	8	9.4	16	18.8	44	51.8
Disagree	9	10.6	9	10.6	12	14.1
Strongly Disagree	0	0	0	0	0	0
Total	85	100	85	100	85	100

Table 4 shows the statistics of competencies of public officials (e.g. 10.60% = strongly agree & 69.40% = agree), which highlights that public sector organizations had competent staff who do not only understands technology but also have ability to deal with challenging situations. Whereas, results of motivational level of public officials show discouraging responses, as 51.80% remain neutral and 14.10% disagreed. However, this was asked to know whether the public-sector employees are ever encouraged, appreciated or simply motivated for adopting modern technologies for proving batter reliable public services.

Table 5. Applicability, Capacity and Utilization of ICTs in Public Sector Organizations

	Availability of ICTs		Capacity of ICTs		Utilization of ICTs	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Strongly Agree	70	82.4	43	50.6	0	0
Agree	15	17.6	36	42.4	11	12
Neutral	0	0	6	7.1	51	60
Disagree	0	0	0	0	23	27.1
Strongly Disagree	0	0	0	0	0	0
Total	85	100	85	100	85	100

Table 5 presents the responses of questions about the availability, capacity and utilization of ICTs Infrastructure. shows that 82.40% strongly agreed and 17.60% were agreed. While the response for the question about the Capacity in ICTs shows that; 50.60% strongly agreed and 42.40% agreed. These responses show encouraging result and promising trend of public sector to promote modernization through deploying ICTs in all public sector organizations. However, the responses about the utilization of ICTs infrastructure were 12.90% agreed, 60% remained neutral and 27.10% disagreed, which discouraging trend showing a dark side of public sector organizations. When one nation has resources it must utilize all these resources efficiently, effectively and in short wisely for her sustainable growth and development.

Table 6. Outcomes of E-Governance in Public Sector Organizations

	Efficiency		Accuracy		Transparency		Reliability		Effectiveness	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Strongly Agree	0	0	0	0	0	0	0	0	0	0
Agree	5	5.9	6	7.10	5	5.9	5	5.9	5	5.90
Neutral	20	23.5	18	21.2	16	18.8	13	15.3	17	20
Disagree	55	64.7	58	68.2	55	64.7	62	72.9	55	64.7
Strongly Disagree	5	5.9	3	3.5	9	10.6	5	5.9	8	9.4
Total	85	100	85	100	85	100	85	100	85	100

Expected outcomes are considered the most crucial aspect of any investment. As in the business studies we calculate the expected return of an investment that allows us to compare it with other opportunities. Though huge investment had been made for adopting E-Governance and different E-Government projects were started to adopt modern administrative practices by utilizing ICTs in public sector. Now the question of evaluation and calculation is getting immense importance. Therefore, this study includes questions about the most promising benefits of deploying ICTs in public sector organizations.

From the above given table it is clear that most of the responses are in negative, such as 70.60% respondent were disagree and strongly disagree(64.70 + 5.90)about the efficiency of public sector services, 71.70% respondent were disagree and strongly disagree (68.20 + 3.50) about the accuracy in public sector working and services, 75.30% respondent were disagree and strongly disagree (64.70 + 10.60) about the accuracy in public sector working and services provision and 78.80% respondent were disagree and strongly disagree 72.90 + 5.90 about the reliability in public sector working and services provision. While, the respondents given information depicts that public sector administrative practices and the modes of services provision are neither cost effective nor accessibility. As numerical figures show that 74.10% respondent were disagree and strongly disagree (64.70 + 9.40) about the cost effectiveness in public sector working and services provision, and 75.30% respondent were disagreeing and strongly disagree (68.20 + 8.20) about the accessibility through public sector working and services provision.

Hypothesis Testing and Discussions

Hypothesis 1: There is significant association between present administrative practices and the level of competencies (i.e. skills, knowledge and abilities) of public officials.

Table 7. Present Administrative Practices and Competencies of Public Officials

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	0.056	0.003	-0.009	0.386

a. Predictors: (Constant), Skills, Knowledge and Abilities of Public Officials

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	β	t	Sig.
1	(Constant)	2.856	.128		22.356	.000
	Skills, Knowledge Abilities of Public Officials	.028	.055	.056	.515	.608

a. Dependent Variable: Present Administrative Practices

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.040	1	.040	.265	.608b
	Residual	12.384	83	.149		
	Total	12.424	84			

a. Dependent Variable: Present Administrative Practices

b. Predictors: (Constant), Skills, Knowledge and Abilities of Public Officials

For **hypothesis 1**, a simple linear regression was calculated to predict present administrative practices based on the level of skills and knowledge with PU officials. A significant regression equation was found (F [1,83] = 0.265, p> .608), with an R2of 0.003). Participants' predicted that present administrative practices are equal to 2.856 + 0.028 when the level of skills and knowledge with PU officials is measured in Likert scale. The above given information depicts that there is no significant association between the level of skills and knowledge with PU officials and present administrative practices. There is less utilization of available human resources in public sector organizations.

Hypothesis 2: There is significant association between the available ICTs infrastructure in public sector and present administrative practices.

Table 8. ICTs Infrastructure in Public Sector and Present Administrative Practices.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of Estimate
1	0.124	0.020	0.008	0.383

a. Predictors: (Constant), ICTs Infrastructure in Public Sector Organizations

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	β	t	Sig.
1	(Constant)	3.086	0.135		22.901	0.000
	Available ICTs Infrastructure in Public Sector Organizations	-0.143	0.109	-0.142	-1.311	

a. Dependent Variable: Present Administrative Practices

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.252	1	.252	1.719	.193b
	Residual	12.171	83	.147		
	Total	12.424	84			

a. Dependent Variable: Present Administrative Practices

b. Predictors: (Constant), ICTs Infrastructure in Public Sector Organizations

The **hypothesis 2** estimates the association between the present administrative practices based on the available ICTs infrastructure in public sector organizations through linear regression analysis. Whereas, a significant regression equation was found (F [1,83] = 1.719 p>.193), with an R2 of 0.003. Participants' predicted that present administrative practices are equal to 2.856 + 0.028 when the availability of ICTs is measured on Likert scale. These statistics depicts that there is no significant association between the present administrative practices and ICTs infrastructure available in public sector organizations. While, only 2% change in dependent variable is occurring due to independent variable. Hence, there is very minor utilization of available ICTs infrastructure in public sector organizations.

Hypothesis 3 (a): There is relationship between the present administrative practices and input variables.

Table 9. Correlation between Present Administrative Practices and Input Variables.

Correlations

Variables		1	2	3	4	5	6	7
1. Present Administrative Practices	Pearson Correlation	1						
	Sig. (2-tailed)							
	N	85						
2. Skills, Knowledge and Abilities	Pearson Correlation	.056	1					
	Sig. (2-tailed)	.608						
	N	85	85					
3. Digital Literacy	Pearson Correlation	.157	.795**	1				
	Sig. (2-tailed)	.151	.000					
	N	85	85	85				
4. Motivation Level	Pearson Correlation	.188	.494**	.620**	1			
	Sig. (2-tailed)	.084	.000	.000				
	N	85	85	85	85			
5. ICTs Infrastructure	Pearson Correlation	-.142	.081	.178	.112	1		
	Sig. (2-tailed)	.193	.462	.103	.305			
	N	85	85	85	85	85		
6. Capacity in ICTs Infrastructure	Pearson Correlation	-.151	-.040	.116	-.336**	.374**	1	
	Sig. (2-tailed)	.169	.719	.289	.002	.000		
	N	85	85	85	85	85	85	
7. Utilization of ICTs Infrastructure	Pearson Correlation	-.001	-.085	.083	-.101	.094	.222*	1
	Sig. (2-tailed)	.996	.440	.448	.360	.391	.042	
	N	85	85	85	85	85	85	85

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The **hypothesis 3 (a)** was tested through Pearson's correlation among present administrative practices and different input variables (Skills and Knowledge, Digital literacy, Motivational Level, ICTs Infrastructure, Capacity in ICTs Infrastructure, and Utilization of ICTs Infrastructure). **Table 9** presents the Pearson correlation for present administrative practices and skills and knowledge which shows weak relationship ($r = 0.056$, $N = 85$, $p > \alpha$, ($p = 0.608$, $\alpha = 0.05$). The Pearson correlation between present administrative practices and digital literacy depicts very weak relationship ($r = 0.157$, $N = 85$, $p > \alpha$, ($p = 0.151$, $\alpha = 0.05$); the Pearson correlation between present administrative practices and motivational level is also depicts weak relationship ($r = 0.188$, $N = 85$, $p > \alpha$, ($p = 0.084$, $\alpha = 0.05$). While, the Pearson correlation between present administrative practices and ICTs Infrastructure shows negative relationship ($r = -.142$, $N = 85$, $p > \alpha$, ($p = 0.193$, $\alpha = 0.05$); the relationship between present administrative practices and capacity in ICTs Infrastructure $r = -.151$, $N = 85$, $p > \alpha$, ($p = 0.169$, $\alpha = 0.05$).Pearson correlation between present administrative practices and utilization of ICTs Infrastructure also represents negative relationship($r = -.001$, $N = 85$, $p > \alpha$, ($p = 0.996$, $\alpha = 0.05$).

The above given numeric show that the present administrative practices are not significantly correlated with the different input variables. Although, there is no significant correlation of skills and knowledge and level of motivation, skills and knowledge and digital literacy, level of motivation and digital literacy, ICTs infrastructure and capacity in ICTs infrastructure at 0.00 significance level.

The **hypothesis 3 (b)** was also tested through Pearson's correlation among different outcome variables (i.e. efficiency, accuracy, transparency, reliability, effectiveness and accessibility) and present administrative practices. The results of correlation shown in **Table 10**, depicts that all outcome variables such as efficiency, ($r = -0.095$, $N = 85$, $p > \alpha$, ($p = 0.386$, $\alpha = 0.05$), accuracy ($r = -0.105$, $N = 85$, $p > \alpha$, ($p = 0.341$, $\alpha = 0.05$), transparency ($r = -.062$, $N = 85$, $p > \alpha$, ($p = 0.576$, $\alpha = 0.05$), reliability ($r = -.072$, $N = 85$, $p > \alpha$, ($p = 0.513$, $\alpha = 0.05$), effectiveness ($r = -0.070$, $N = 85$, $p > \alpha$, ($p = 0.527$, $\alpha = 0.05$) and accessibility ($r = -0.070$, $N = 85$, $p > \alpha$, ($p = 0.527$, $\alpha = 0.05$) has negative relationship with present administrative practices.

These results depict that the present administrative practices are not actualizing the expected outcomes of E-Governance. However, the relationships of different outcomes with each other are strongly correlated which shows their interdependence on each other for the common goal.

Hypothesis 3 (b): There is relationship between the Present Administrative Practices and outcome variables.

Table 10. Correlation between Present Administrative Practices and Outcome.

Correlations

Variables		1	2	3	4	5	6	7
1. Present Administrative Practices	Pearson Correlation	1						
	Sig. (2-tailed)							
	N	85						
2. Efficiency	Pearson Correlation	-.095	1					
	Sig. (2-tailed)	.386						
	N	85	85					
3. Accuracy	Pearson Correlation	-.105	.812**	1				
	Sig. (2-tailed)	.341	.000					
	N	85	85	85				
4. Transparency	Pearson Correlation	-.062	.783**	.786**	1			
	Sig. (2-tailed)	.576	.000	.000				
	N	85	85	85	85			
5. Reliability	Pearson Correlation	-.072	.772**	.801**	.753**	1		
	Sig. (2-tailed)	.513	.000	.000	.000			
	N	85	85	85	85	85		
6. Cost Effective	Pearson Correlation	-.070	.623**	.726**	.855**	.857**	1	
	Sig. (2-tailed)	.527	.000	.000	.000	.000		
	N	85	85	85	85	85	85	
7. Accessibility	Pearson Correlation	-.070	.776**	.856**	.806**	.803**	.706**	1
	Sig. (2-tailed)	.527	.000	.000	.000	.000	.000	
	N	85	85	85	85	85	85	85

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Hypothesis 4 (a): There is relationship between the Inter-Organizational Information Integration and input variables.

Table 11. Inter-Organizational Information Integration and Input Variables.

Correlations								
Variables			1	2	3	4	5	6	7
1.	Inter-organizational Information Integration	Pearson Correlation	1						
		Sig. (2-tailed)							
		N	85						
2.	Skills, Knowledge and Abilities	Pearson Correlation	.064	1					
		Sig. (2-tailed)	.562						
		N	85	85					
3.	Digital literacy	Pearson Correlation	.090	.795**	1				
		Sig. (2-tailed)	.412	.000					
		N	85	85	85				
4.	Motivational Level	Pearson Correlation	.145	.494**	.620**	1			
		Sig. (2-tailed)	.187	.000	.000				
		N	85	85	85	85			
5.	ICTs Infrastructure	Pearson Correlation	-.100	.081	.178	.112	1		
		Sig. (2-tailed)	.361	.462	.103	.305			
		N	85	85	85	85	85		
6.	Capacity in ICTs Infrastructure	Pearson Correlation	-.171	-.040	.116	-.336**	.374**	1	
		Sig. (2-tailed)	.119	.719	.289	.002	.000		
		N	85	85	85	85	85	85	
7.	Utilization of ICTs Infrastructure	Pearson Correlation	-.076	-.085	.083	-.101	.094	.222*	1
		Sig. (2-tailed)	.490	.440	.448	.360	.391	.042	
		N	85	85	85	85	85	85	85

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 11 presents the results of Pearson's correlation among Inter-Organizational Information Integration and different input variables (i.e. skills, knowledge and abilities, digital literacy, motivational level, ICTs infrastructure availability, capacity, and utilization).

The results of **Hypothesis 4 (a)** illustrates that inter-organizational information has weak relationship with skills, knowledge and abilities ($r = 0.064$, $N = 85$, $p > \alpha$, ($p= 0.562$, $\alpha = 0.05$), digital literacy ($r = 0.090$, $N = 85$, $p > \alpha$, ($p= 0.412$, $\alpha = 0.05$) and motivation of public officials ($r = 0.145$, $N = 85$, $p > \alpha$, ($p= 0.187$, $\alpha = 0.05$). Whereas, the correlation between the available ICTs infrastructure ($r = -0.100$, $N = 85$, $p > \alpha$, ($p= 0.361$, $\alpha = 0.05$), the capacity of ICTs infrastructure ($r = -0.171$, $N = 85$, $p > \alpha$, ($p= 0.119$, $\alpha = 0.05$) and the utilization of ICTs infrastructure ($r = -0.076$, $N = 85$, $p > \alpha$, ($p= 0.490$, $\alpha = 0.05$) has weak negative relationship with inter-organizational information integration.

However, these trends disclosed the under-utilization or no-utilization of available resources in public-sector organizations, to improve inter-organizational information integration for the successful E-Governance.

Whereas, the **Hypothesis 4 (b)** was tested through Pearson's correlation among present administrative practices and different input variables (efficiency, accuracy, transparency, reliability, cost effectiveness, accessibility) that provide us strange results.

The results of Pearson correlation between the inter-organizational information integration and efficiency ($r = -0.189$, $N = 85$, $p > \alpha$, ($p = 0.083$, $\alpha = 0.05$), accuracy ($r = -0.201$, $N = 85$, $p > \alpha$, ($p = 0.065$, $\alpha = 0.05$), transparency ($r = -0.147$, $N = 85$, $p > \alpha$, ($p = 0.179$, $\alpha = 0.05$), reliability ($r = -0.167$, $N = 85$, $p > \alpha$, ($p = 0.127$, $\alpha = 0.05$), effectiveness ($r = -0.157$, $N = 85$, $p > \alpha$, ($p = 0.152$, $\alpha = 0.05$) and accessibility ($r = -0.157$, $N = 85$, $p > \alpha$, ($p = 0.152$, $\alpha = 0.05$) show the negative relationship. However, there is strong positive relationship of these outcome variables with one another. This situation depicts that present practice of inter-organizational information integration are not compatible to E-Governance strategies. While, the successful E-Governance necessitates the proper utilization of available ICTs infrastructure for inter-organizational information integration.

Hypothesis 4 (b): There is relationship between the Inter-Organizational Information Integration and Output Variables.

Table 12. Inter-Organizational Information Integration and Output Variables.

Correlations

Variables		1	2	3	4	5	6	7
1. Inter-organizational Information Integration	Pearson Correlation	1						
	Sig. (2-tailed)							
	N	85						
2. Efficiency	Pearson Correlation	-.189	1					
	Sig. (2-tailed)	.083						
	N	85	85					
3. Accuracy	Pearson Correlation	-.201	.812**	1				
	Sig. (2-tailed)	.065	.000					
	N	85	85	85				
4. Transparency	Pearson Correlation	-.147	.783**	.786**	1			
	Sig. (2-tailed)	.179	.000	.000				
	N	85	85	85	85			
5. Reliability	Pearson Correlation	-.167	.772**	.801**	.753**	1		
	Sig. (2-tailed)	.127	.000	.000	.000			
	N	85	85	85	85	85		
6. Cost Effective	Pearson Correlation	-.157	.623**	.726**	.855**	.857**	1	
	Sig. (2-tailed)	.152	.000	.000	.000	.000		
	N	85	85	85	85	85	85	
7. Accessibility	Pearson Correlation	-.157	.776**	.856**	.806**	.803**	.706**	1
	Sig. (2-tailed)	.152	.000	.000	.000	.000	.000	
	N	85	85	85	85	85	85	85

**. Correlation is significant at the 0.01 level (2-tailed).

Conclusion.

The major concern of this study was to explore the role of inter-organizational information integration in successful E-Governance. The results reveal that the public sector organizations in Pakistan are not utilizing the available resources (e.g. ICTs and competent human resource) to their optimum level despite having the potential capacity. While, the underutilization of these resources not only cost the government but instigating backwardness of public sector organizations in Pakistan. Whereas, this survey also highlights the differences in present practices, officials' preferences and stakeholders' demands. However, the findings revealed the positive attitude of respondents towards the inter-organizational information integration for greater efficiency, accuracy, transparency, accountability and reliability of public sector processes.

Acknowledgement.

Author's Contribution. All the authors contributed equally.

Conflict of interest. We declare no conflict of interest for publishing this manuscript in IJIST.

Project details. NIL

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IJIST
ISSN : 2618-1630

Appraisal of Urban Sprawl in Mega Cities of Punjab Pakistan in context of Socio-Political Issues using RS/GIS.

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Citation | Saifullah.M, Zafar.M, Sohail.A, Mehmood.F, Musharaf.M, Khan.J, Ashfaq.A and Mahmood.S.A. "Appraisal of Urban Sprawl in Mega Cities of Punjab Pakistan in context of Socio-Political Issues using RS/GIS". International Journal of Innovations in Science & Technology, Vol 01 Issue 03: pp 108-119, 2019.
DOI | https://doi.org/10.33411/IJIST/2019010308
Received | May 26, 2019; Revised |June 28, 2019 Accepted | June 29, 2019; Published | June 30, 2019.

Abstract.

Urbanization has become a hot issue in context of environmental and socio-political scenarios which is addressed at every forum internationally. The mega cities are considered the main origin of socio-economic development which caused to emerge a number of issues like biodiversity, environmental degradation, resource consumption, implementation of law and order and provision of basic facilities to the general public. The area under investigation consists of Lahore, Gujranwala and Sheikhupura. The study site was bounded by 73-75 E longitudes and 31-33 N latitudes. We used Landsat satellite data to map Spatio-temporal variations in urban sprawl from 1990 to 2019 with a temporal window of 15 years. The Landsat data is free, highly reliable and considered as primary source. The classification results show that the total area of study site was site was 29355 km^2 including 21933km^2 were green index 4595 km^2 was under human settlements and 2827 km^2 was the waterbody in 1990. The classification of Landsat image of the year 2005 describes that area of human settlements was increased to 9366 km^2, the volume of water body was reduced to 2111km^2 and the vegetation was also degraded to 17878km^2. Again, the urban area was computed using satellite imagery for the year 2019 which was 16105km^2 in 2019. Kappa stat proved the accuracy of supervised classification what was around 87%. Remotely sensed datasets proved the reliability of Landsat satellite images for estimation of urban sprawl during last three decades.

Keywords: socio-political development, Urban Sprawl, Landsat, Biodiversity, Classification.

Introduction.

Urbanization has become a hot issue in context of environmental and socio-political scenarios which is addressed at every forum internationally. About 15% of the world's population was urbanized in 1990 but now it is expected that half of world's population will be urbanized by 2030 [1]. This urbanization growth has devasted urban balance and effected the sustainable development. The situation has become worse which lead to severe environmental issues and the climate change [2]. This climate change has affected the cropping system [3] glacial melting [4], severe flooding and droughts [5].

Many studies have indicated a big difference in urban temperature in comparison to its outskirts [2,6,7,8]. Removal of vegetation for construction of buildings, malls and plazas, is considered the main cause of rise in urban temperatures [9]. Urban transport adds a variety of pollutants in the atmosphere through tail pipe emissions which cause to block the reflected solar radiations, and finally result into urban heat island [2]. The removal of vegetal cover from urban areas cause the solar radiations to approach earth's surface directly which result to an abrupt increase in urban temperatures in comparison to its surroundings [2].

The mega cities are considered the main origin of socio-economic development which caused to emerge a number of issues like biodiversity, environmental degradation, resource consumption, implementation of law and order and provision of basic facilities to the general public [10,11,12,13]. These issues need to get resolved on emergency grounds.

Sustainability and urban development have been widely focused in various studies [11,12,14,15]. Some studies have proved that regional sustainability is the key parameter to evaluate the credibility and authenticity of urbanization [12,14,15] however, many others believe that urban sustainability is oxymoron [11]. Urban sustainability has two main pillars that include ecological and social sustainability. Ecological sustainability is concerned with ubiquitous urban sprawl while social sustainability relates to urban population growth. Recent urban growth in Asian countries put huge pressure on its ecological system which caused to emerge new settlements e.g., highways that eaten up agricultural fertile lands, wetlands, forests and other lands. The socio-economic sustainability is concerned with two main themes i.e., economic balance and social equity [16,17]. Social inequity is concerned with all the issues associated with society that includes social injustice, welfare of migrants [18], rural-urban settlement gap, health issues, air pollution, traffic injury and occupational hazards [19,20,21].

In the very first step, urban instability hit the society by disturbing literary, mobilization, income, education, political participation and health. Next, these issues become prominent when the urbanization effects the carrying capacity of a particular urban society.

Rapid urbanization and industrialization were faced by various developed countries [22]. Urbanization of ancient times, was associated with employment opportunities therefore, people rushed and settled themselves in surroundings of urban societies for their livelihood. The socio-economic development results in peace and prosperity of a region.

The main objective of this research was to investigate the urban sprawl in mega cities of Punjab Pakistan in context of socio-political issues using Remote Sensing and Geographic Information System (GIS).

Material and Methods.

Study site.

We selected three adjacent districts in Punjab Pakistan where high rates of urban sprawl were reported in recent three decades. The area under investigation consists of Lahore, Gujranwala and Sheikhupura. The study site was bounded by 73-75 E longitudes and 31-33 N latitudes. The study site is mapped in Figure 1.

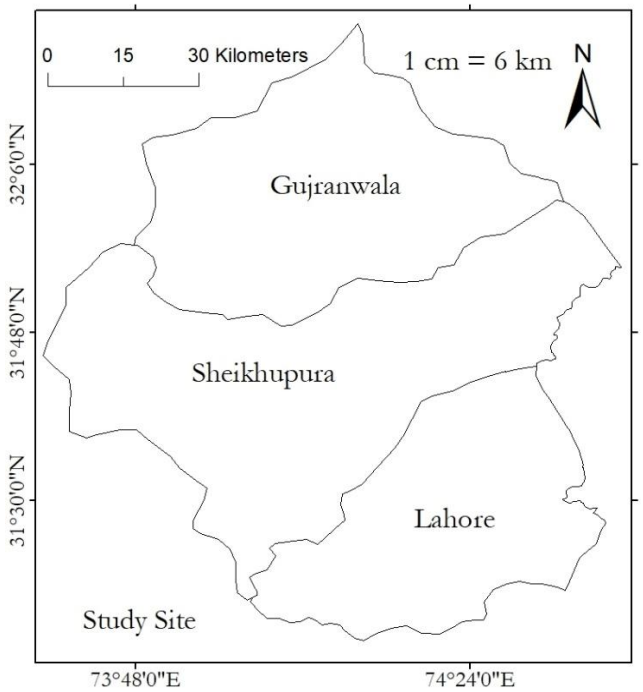


Figure 1. Study site.

The methodology used in this research is mapped in Figure 2, which describe the complete mechanism to compute urban growth from satellite image acquisition to final display of thematic maps.

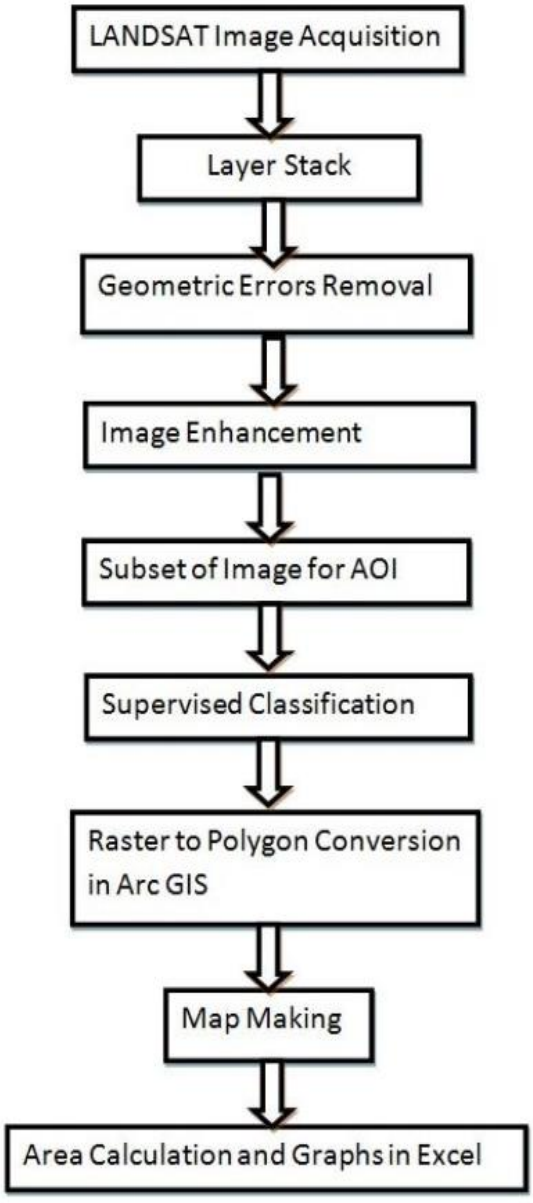


Figure 2. Methodology.

We used Landsat satellite data to map Spatio-temporal variations in urban sprawl from 1990 to 2019 with a temporal window of 15 years. The Landsat data is free, highly reliable and considered as primary source. We obtained satellite images of Landsat 5 for the years 1990 and 2005 and Landsat 8 for the year 2019. The complete description of satellite images used to accomplish this research is mentioned in Table 1.

Table 1. Landsat 5, 8 image acquisition dates.

Sr No.	Satellite	Date	Resolution	Bands
1	Landsat 5	Nov 11, 1990	30 m^2	7
2	Landsat 5	March 16, 2005	30 m^2	7
3	Landsat 8	April 01, 2019	30 m^2	11

A Landsat image is comprised of a number of spectral bands, commonly known as layers. In the first step, these layers were combined to obtain a satellite image using layer stack utility in Erdas Imagine 14. This utility is capable to bind these layers carefully without merging their information at cell level. An overview of layer stacking is shown in the Figure 3,

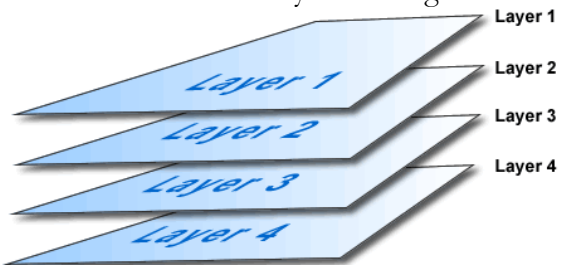


Figure 3. Layer staking in Erdas Imagine.

The swath width of Landsat image is 185km^2. It is a very large image in comparison to the spatial extent of the study site. Therefore, it was important to figure out the investigation site from a large dataset for saving the processing time. We used the mask of study site and applied "Extract by Mask" to obtain the investigation site only from the Landsat images.

All satellite images were checked geometrically to cross validate the spatial locations of various landuse features. To do so, we marked some features on satellite images and checked their locations through Global Positioning System (GPS) but we could not find considerable variations.

Classification is used to demarcate and discriminate between various landuse features existing in the study site. The main objective of classification was to compute the volume in term of area of existing features. There are two types of classifications, 1) Supervised 2) Unsupervised. In supervised classification, we do recognize landuse features to computer by selecting trainee samples. Software intake these sample sites and recognize the existing landuse. Supervises classicization is considered technically correct in comparison to unsupervised classification. We computed the variations in area of landuse features through supervised classification.

Kappa coefficient is considered a good indicator to determine the accuracy of supervised classification [23]. It is widely used therefore, we applied Kappa stat for accuracy assessment of supervised classification.

Result and discussion.

The supervised classification of Landsat images is mapped in figure 4. Figure 4 describe that urban boundaries have sprawled beyond the limits during last three decades which has eaten up fertile agriculture lands. Figure 4(A) is showing the spatial extent of water body, vegetation and the built-up area in the year 1990. According to figure 4 (A), the total area of study site was 29355 km^2 including 21933km^2 were green index 4595 km^2 was under human settlements and 2827 km^2 was the waterbody in 1990.

Figure 1(B) is showing that the area of human settlements had been increased in 2005 in comparison to 1990 from 4595km^2 to 9366 km^2, the volume of water body was reduced to 2111km^2 and the vegetation was also degraded to 17878km^2.

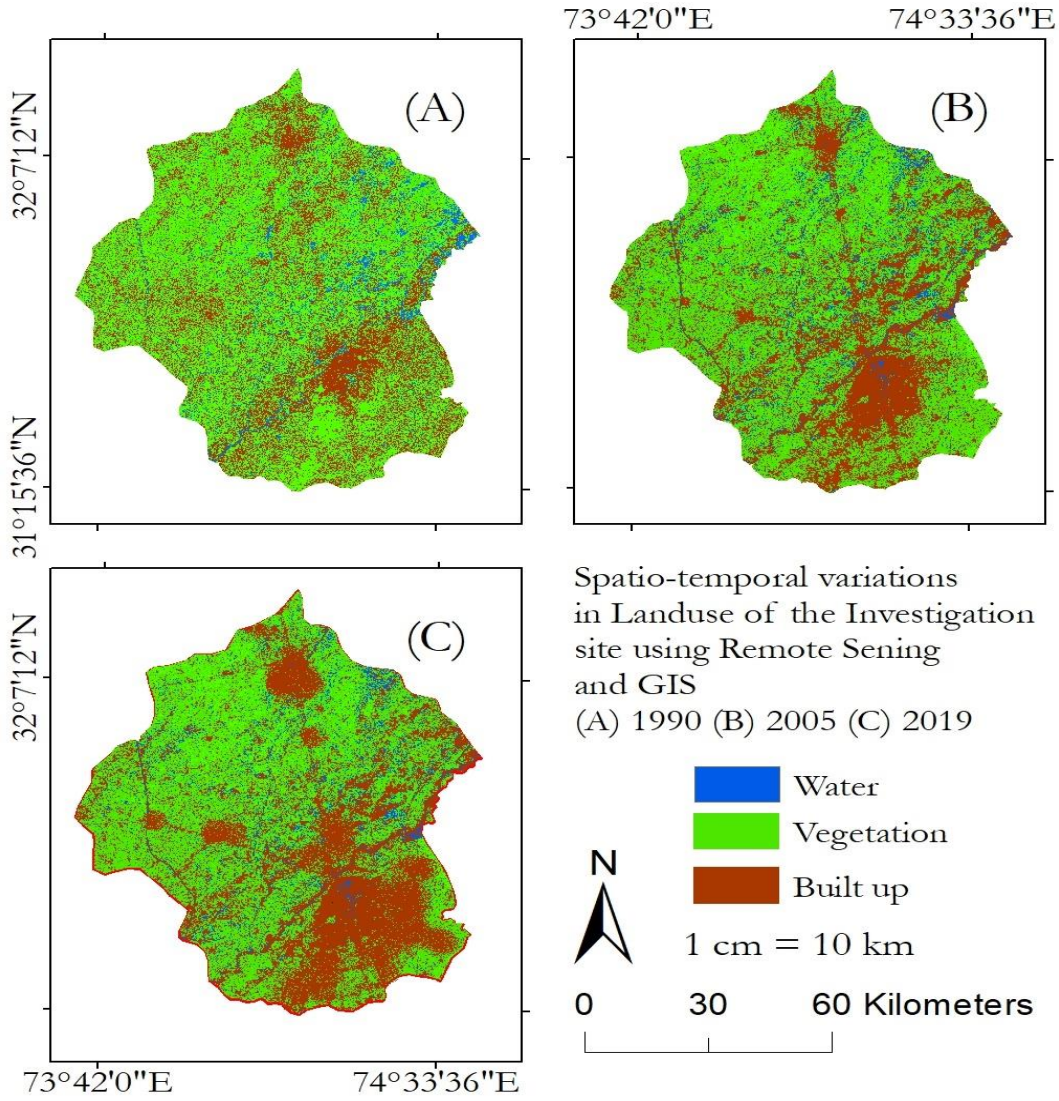
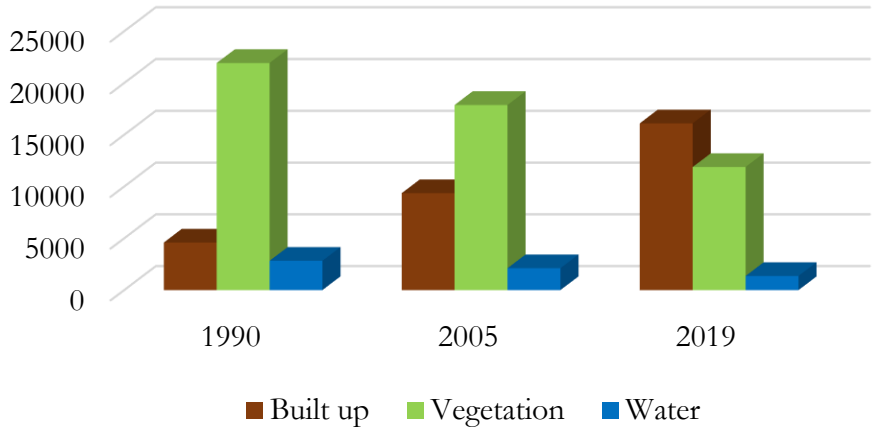


Figure 4. Spatio-temporal variations in landuse of the investigation site from 1990-2019 having a temporal window of 15 years.

Figure 1(c) was mapped using Landsat 8 image of year 2019 which show a reasonable jump in built up area that reached to 16105km^2 and hence a decline to vegetation as the area under vegetation was observed as 11888km^2. Figure 5 is showing temporal variations in built up, vegetation and the water body.



The accuracy assessment of supervised classification for the years 1990, 2005 and 2019, we applied Kappa stat on the classified images and applied 25 sample points including 5 to waterbody, 10 to build up and the vegetation. The calculations are as follows,

Table 2: Sample points applied to classified image for the year 2019.

Class	Vegetation	Build-up	Water	Total-User
Other-vegetation	9	1		10
Build-up Area		10		10
Water	1		4	5
Total-Producer	**10**	**11**	**4**	**25**

TS= Total number of Sample

TSC= Total number of corrected Sample

$$\text{Kappa coefficients}(\mathcal{K}) = \frac{(\mathcal{TS} * \mathcal{TCS}) - \sum(col.total * Row\ total)}{(\mathcal{TS})^2 - \sum(col.total * Row\ total)} * 100$$

$$\mathcal{K} = \frac{[(25 * 23) - \{(10 * 10) + (10 * 11) + (5 * 4)\}]}{(25)^2 - \{(10 * 10) + (10 * 11) + (5 * 4)\}} * 100$$

$$\mathcal{K} = \frac{[(575) - \{(100) + (110) + (20)\}]}{(625) - \{(100) + (110) + (20)\}} * 100$$

$$\mathcal{K} = \frac{575 - 230}{625 - 230} * 100$$

$$\mathcal{K} = \frac{345}{395} * 100$$

$$\mathcal{K} = 0.873 * 100 = 87.34\%$$

Table 3. Sample points applied to classified image for the year 2005.

Class	Vegetation	Build-up	Water	Total-User
Vegetation	8	2		10
Build-up Area		10		10
Water	1		4	5
Total-Producer	**9**	**12**	**4**	**25**

$$\text{Kappa coefficients}(\mathcal{K}) = \frac{(\mathcal{TS} * \mathcal{TCS}) - \sum(col.total * Row\ total)}{(\mathcal{TS})^2 - \sum(col.total * Row\ total)} * 100$$

$$\mathcal{K} = \frac{[(25 * 22) - \{(10 * 9) + (10 * 12) + (5 * 4)\}]}{(25)^2 - \{(10 * 9) + (10 * 12) + (5 * 4)\}} * 100$$

$$\mathcal{K} = \frac{[(550) - \{(90) + (120) + (20)\}]}{(625) - \{(90) + (120) + (20)\}} * 100$$

$$\mathcal{K} = \frac{550 - 230}{625 - 230} * 100$$

$$\mathcal{K} = \frac{320}{395} * 100$$

$$\mathcal{K} = 0.81 * 100 = 81\%$$

Table 4. Sample points applied to classified image for the year 1990.

Class	Vegetation	Build-up	Water	Total-User
Vegetation	9	1		10
Build-up		9	1	10
Water	1		4	5
Total-Producer	**10**	**10**	**5**	**25**

$$\text{Kappa coefficients}(\mathcal{K}) = \frac{(\mathcal{TS} * \mathcal{TCS}) - \sum(col.total * Row\ total)}{(\mathcal{TS})^2 - \sum(col.total * Row\ total)} * 100$$

$$\mathcal{K} = \frac{[(25 * 22) - \{(10 * 10) + (10 * 10) + (5 * 5)\}]}{(25)^2 - \{(10 * 10) + (10 * 10) + (5 * 5)\}} * 100$$

$$\mathcal{K} = \frac{[(550) - \{(100) + (100) + (25)\}]}{(625) - \{(100) + (100) + (25)\}} * 100$$

$$\mathcal{K} = \frac{550 - 225}{625 - 225} * 100$$

$$\mathcal{K} = \frac{325}{400} * 100$$

$$\mathcal{K} = 0.8125 * 100 = 81.25\%$$

It determines that the classified image obtained using satellite image for the year 1990 was 81.25%. The classified image for the year 2005 was 81% correct and the satellite image for the year 2019 was 87.34% correct.

Discussions

The results proved that most of urban sprawl occurred in Lahore and Gujranwala during 1990-2019. It was observed that mostly migrants rushed toward urban areas in search of education and employment. Lahore is known as an origin of education. Therefore, Lahore was a hotspot for knowledge seekers.

People moved toward Lahore to get knowledge and stayed on rent with permanent residents. Soon, this trend become a business and the residents built new settlement to offer their houses on rent to migrants. In this way, about 85% houses were built without following any architectural by laws that devasted the complete face of the city. Most of migrants did not return to their native cities because they engaged themselves in some professional jobs and become permanent residents which cause to increase the urban area.

Lahore and Gujranwala have limited health facilities in comparison to existing population. Mostly hospitals were built by British and a few were built after independence. Therefore, the increasing population is given cheap medical service due to lack of medical facilities.

It is very difficult to apply law and order to ensure the security of masses with limited resources. Therefore, the crime rate had been increasing in Lahore and Gujranwala with passage of time since 1990. Transport is a remarkable problem of a mega city. It is very difficult to manage transportation of a big population. For this reason, many underpasses, overhead bridges, tunnels and metro lines were constructed which are serving within cities but traffic remains out of control.

On the other hand, Gujranwala is an industrial city. There were 550 industries in Gujranwala in 1995 that raised up to 2131 in 2019. These industries are famous for manufacturing goods of export quality which remained an attraction for labor and other professions to earn their livelihood which cause increase in urban size.

A city faces a big burden of accommodation of migrants, hence a planned city built by senior architects is highly needed but unfortunately migrants built their houses by their own in Lahore and Gujranwala. Therefore, insecure and ill planned houses were built.

Urban climates are getting polluted day by day by industrial emission and vehicle discharge. The statistics of Gujranwala describe that the amount of CO was 105 PPBV in 1995 that increased up to 130 PPBV in 2018, CO_2 increased from 363 PPM to 421 PPM. The number of vehicles were enhanced from 25730 in the year 2000 to 796751 in 2016. There were 550 industries 1995 which increased up to 2131 in 2016. All these activities which are against the human health are a question mark to a step forward for a sustainable future.

Conclusion.

Urban sprawl is one of major problems globally for developing countries like Pakistan. It is addressed at every forum and require careful attention for immediate solutions. It is hard to draw city boundaries by physical visits therefore; remotely sensed datasets are highly reliable for identification of existing land use. But a limitation that we faced to fulfill the project successfully, was the coarse resolution of Landsat imagery. We executed field visits to determine the accuracy of results. One can get efficient results with improved satellite imagery of high resolution.

Author's Contribution. All the authors contributed equally.
Conflict of interest. We declare no conflict of interest for publishing this manuscript in IJIST.
Project details. NIL

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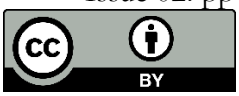

ISSN : 2618-1630

Analysis of Flood Damage Assessment through WorldView-2, Quick Bird and Multispectral Satellite Imagery in Southern Punjab, Pakistan

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Citation | Essa N.D., Amir M., Mahmood S.A., Riaz F., Farooq N., Rasheed R., Fatima S.Q., Batool S., Mehmood S.A., Kaukab I.S. Saeed. F. Analysis of Flood Damage Assessment through WorldView-2, Quick Bird and Multispectral Satellite Imagery in Southern Punjab, Pakistan International Journal of Innovations in Science & Technology, Vol 01 Issue 03: pp 120-139, 2019.

DOI | https://doi.org/10.33411/IJIST/2019010310
Received | June 28, 2019; Revised |July 17, 2019 Accepted | July 22, 2019; Published | July 25, 2019.

Abstract. Pakistan has faced numerous natural disasters like floods, earthquakes, landslides and environmental degradation which severely affects the Pakistan's economy and results in various problems like causalities, diseases, water stress and severe damages (e.g., houses, public infrastructure and agricultural land erosion). There is a lack of systematic approaches to analyze pre and post damage assessment for estimation of exact loses and the total cost for rehabilitation of damaged infrastructure in an efficient way. There exist a variety of mechanisms but GIS based flood mapping is considered the most efficient to manage the flood situation. This study is focused on evaluation of flood affected areas especially in Punjab using WorldView-2, 8-band multi-spectral imagery by applying Remote Sensing (RS) and GIS techniques. The research area is comprised of Kot Addu and Muzaffargarh Districts in Punjab province of Pakistan that faced a catastrophic super flood of 2010. The WorldView-2, Quick Bird and multispectral satellite imagery are capable of making better decisions and assessment of flood effected area accurately. RS and GIS techniques can achieve the objectives and significant analyses through visual interpretations. These techniques are also used to identify

the flood affected regions. The study site was examined by applying supervised classification on the basis of the training areas which were obtained during the field surveys in the study site. Supervised classification determines that 16900.96 Hectors of agriculture land was damaged while Sparse Riverine Forest had the area 44.52 hectors. The damaged built-up area was 1805.78 Hectors. RS and GIS techniques are efficient for flood mapping.

Keywords: Multi-spectral bands, GIS, RS, Visual Interpretation Elements, Supervised Classification, Worldview-2 and Quick Bird.

Introduction.

Natural disasters such as flood, tsunami, typhoon forest fire, earthquake, volcanic eruption and debris flow often cause interference to cultural environment and physical structures, houses and infrastructure [1]. Flooding creates a marvelous influence on human life and has great worldwide importance regarding hydrological cycle [2]. Each year natural hazards, such as earthquake, typhoon, flood, and debris flow etc., cause tremendous loss of properties and human lives in the world [3]. The hazardous floods are the most shocking, widespread and frequent, amongst other natural disasters [4,5]. Flood vulnerability represents the potential of flood that portends floodplain inhabitant's lives and their assets and agricultural land [6]. Floodplain is relatively plane and low-lying area where water flow over the river banks [7,8,9,10]. As floods are the natural phenomenon but flood hazards cause to devastate the social life of inhabitants, business, housing, and agricultural activities, which often severely damaged during flood [6,11,12,13].

In Pakistan, floods are classified on the basis of pivotal factors e.g., riverine flood, dam break flood and storm surge floods [14]. Riverine flood happens due to the inflow of water to a river, when water surpasses to river's channel capacity [12]. In Pakistan, flood history from 1950-2015, highlights many high medium and low-level floods along Indus River and its connecting channels but the flood event occurred in 2010 was super flood which resulted in major damages to adjacent districts along Indus and Chenab River. According to federal flood commission of Pakistan about 1,985 people lost their lives, 1.6 million houses were smashed, 17,553 villages and a total area of 160,000 km^2 were affected by the flood occurred in 2010. This flood damaged infrastructure, roads, irrigation and drainage system throughout the country and effected the social life of about 20 million people across the country.

In some scenario, flood safety works fascinate high value land use in flood hazards areas but provide false sense of security to floodplain dwellers and their properties therein because these works often get breached during high flood flow [15, 12]. The main factor of breaks in river channels is the sand molding which is due to shocking floods [16].

Pakistan is struggling to manage natural hazards for survival from nastiest catastrophic conditions which may occur in future. About one fifth of Pakistan's area was affected by flood water in 2010 which pushed thousands of families to displace for their survival and leaving millions as homeless. The low-lying Indus belt in the Punjab Pakistan represents a flood prone zone. This flood hit the areas along Chenab and Sutlej River. It destroyed the existing infrastructure completely. Both the cultural and economic standards of life had been drained out in rain. Flood 2010 covered the complete study site in comparison to floods of 2014, 2015 as shown in figure 1.

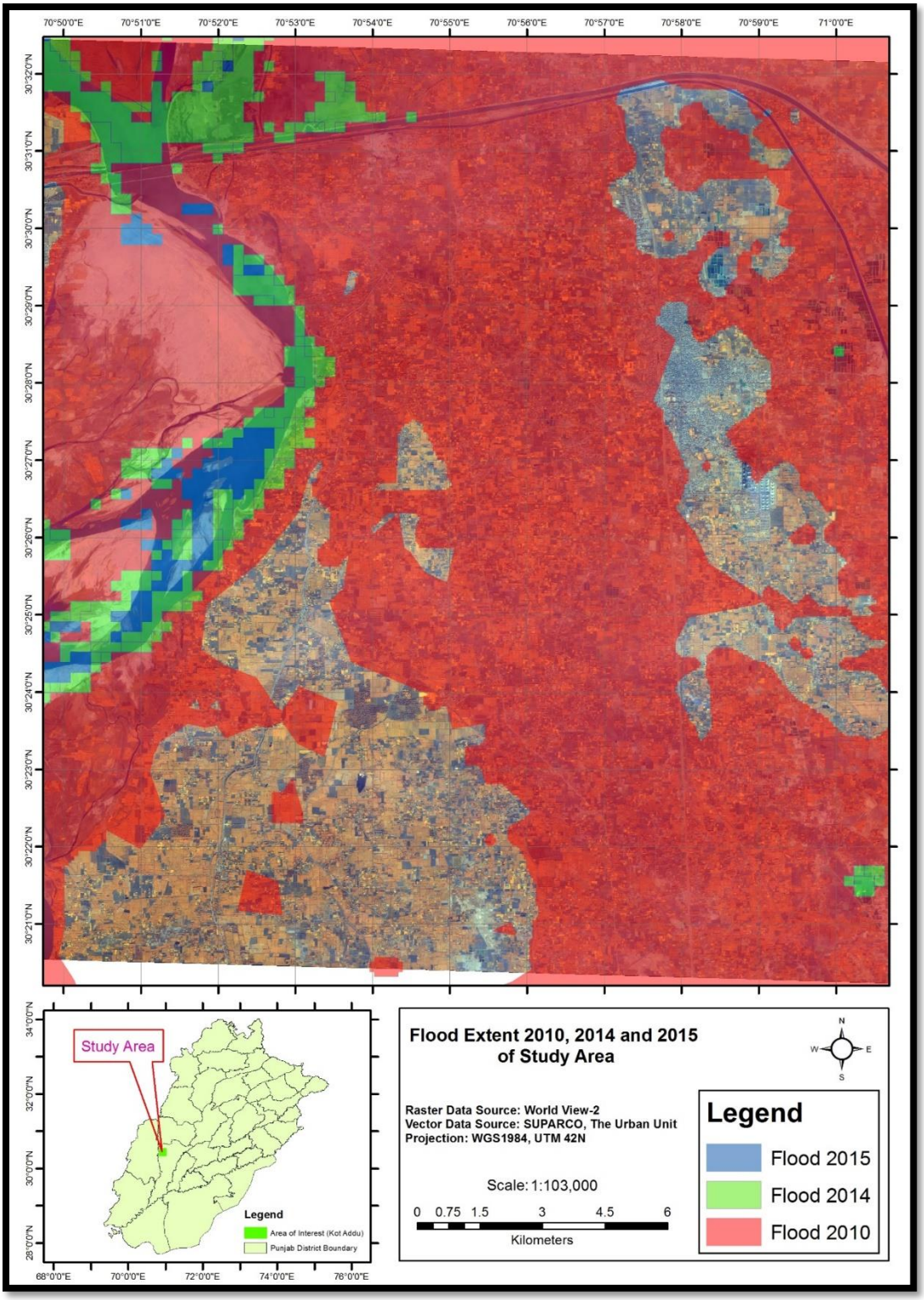


Figure 1: Flood Extent 2010, 2014 and 2015 in the study site.

The management of a disaster in efficient ways and the rehabilitation activities are significant for the prosperity of affected people. Intime management of Hazards and damage assessments are key indicators for defining actions that communities can take to reduce socio-economic losses [3]. Adequate understating of the flood assessment can support the decision makers in choice of engineering or non-engineering measures for flood damages [17].
There may be different measures that can be taken for hazard management in a region, such as land use planning and management, construction of engineering structures and flood monitoring or warning systems, etc. The effectiveness of these alternatives can be more properly evaluated if the comparisons are based on the risk reductions from the implementation of that measure [18].

In order to estimate the damages occurred due to flood hazards, optical data is widely used [19,20,21,22,23,24,25,26]. For land cover identification and assessment accurately, satellite imagery is considered as dominant tool [27]. The satellite imagery having spatial resolution more than 5 meter creates great impact to estimate the accurate extent of flood [28]. The spatial resolution provides great value to understand the variations in topography and various natural and manmade activities [29]. In order to execute the classification for land cover mapping, usually multispectral imagery is used [30]. For image exploration, classification is considered as the most significant part [31] used to retrieve the information about different land cover classes from the image. To take trainee areas for supervised classification, different band combinations and interpretation keys e.g., texture, tone pattern, shadow, lightness/darkness, associate and situation of land cover features in image are widely used[30].

A variety of classification techniques are available for Landuse Landcover reorganization [32]. Supervised classification is one of these techniques widely used in various applications. Supervised classification is based on detection algorithm using pixels from known reference samples, usually located within a scene, as a key for comparison to other pixels in the same scene [33].

Assessment of flood affected areas was examined using WorldView-2 8-band sample imagery. The Hyper-spectral imagery has capacity to make better decision and assessment of the focused area. GIS and RS techniques are used in this study to achieve the objectives and relevant analysis. Current status of the Land Cover and Land Use (LULC) is estimated by using supervised classification on the basis of the training areas which were selected during the field survey through GPS.

LULC classification can be seen on a continuum, starting with a basic estimation of land cover through broad categories, like farmland and urban areas, to feature extraction, like road networks, buildings, and trees [29]. The visual interpretation technique is the most precise approach [34] and is used for comparison of supervised classification results and identification of flood affected areas. WorldView-2 imagery has specific cartelistic with 1.86 m multispectral resolution by using False Color Composite (FFC), panchromatic 0.46m imageries. The data was compared with the Quick Bird pre-imagery and digital photographs to sort out the damage areas.

Digital Globe World View-2 has capacity to discriminate features in the study site in a better way through bathymetric analysis and vegetative analysis with more accuracy as it is possessing 8-spectral bands with additional four bands. With hyper spectral and coastal band to asses and estimate the flood extent, damage, harm etc. World View-2 consists of one

panchromatic and two multispectral imaging sensors; MS1 includes Blue, Green, Red, and Near-IRI and MS2 includes coastal Blue, Yellow, Red Edge and Near-IRI [35].

The objective of this study was to utilize Remote Sensing (RS) techniques with the available Geographic Information System (GIS) to develop a rehabilitation model consisting of transparent information regarding total flood affected area & identification of demolished household, damaged infrastructure, flooded crops to achieve the level of better decision making to help the responsible authorities for developing, designing, and operating flood control infrastructure and preparing aid and relief operations for high-risk areas during future floods.

Material and Methods.

Investigation site.

The study was conducted in Tehsil Kot Addu of District Muzaffargarh, Punjab. The spatial location of study area is 70.929°E & 30.944°N. District Muzaffargarh is among the severely damaged districts during the flood because it is surrounded by two rivers (Chenab and Indus). Both rivers were fully flooded which dragged most of the district area under water as shown in Figure 2.

Kot Addu is the severely damaged tehsil of the district Muzaffargarh as shown in the table 1. The number of houses damaged in Kot Addu reached up to 71,104 along with six fully affected basic health units leading to miseries and displacements [18].

Table 1: Summary of Total Affected Area of *District Muzaffargarh*

Name of Tehsil	Total UCs	Total Villages	Affected Villages	Several Affected UCs (>50%)	Moderately Affected UCs (<50%)
Muzaffargarh	35	426	317	12	17
Kot Addu	28	341	174	21	2
Alipur	14	124	72	4	7
Jatoi	16	93	35	0	5
Total	**93**	**984**	**598**	**37**	**31**

Data used

For this study hyperspectral imagery of spatial resolution 1.86m and panchromatic of spatial resolution 0.46m of World View-2, Quick Bird Scene and the GIS data (Source : The Urban Unit) are used. About 400 Square kilometer area (38913.87 Hectors) of Tehsil Kot Addu, district Muzaffargarh was acquired from Digital globe for the research purpose. World view- 2 has 8 bands with 4 extra bands. The spectral range of the 8-bands is given as in Table-2.

Table 2: WorldView-2 Multispectral Range

Sr. No.	Band Name	Spectral Range
1	Coastal Blue	400 nm-450 nm
2	Blue	450 nm-510 nm
3	Green	510 nm-580 nm

4	Yellow	585 nm-625 nm
5	Red	630 nm-690 nm
6	Red-Edge	705 nm-745 nm
7	NIR1	770 nm-895 nm
8	NIR2	860 nm-1040 nm

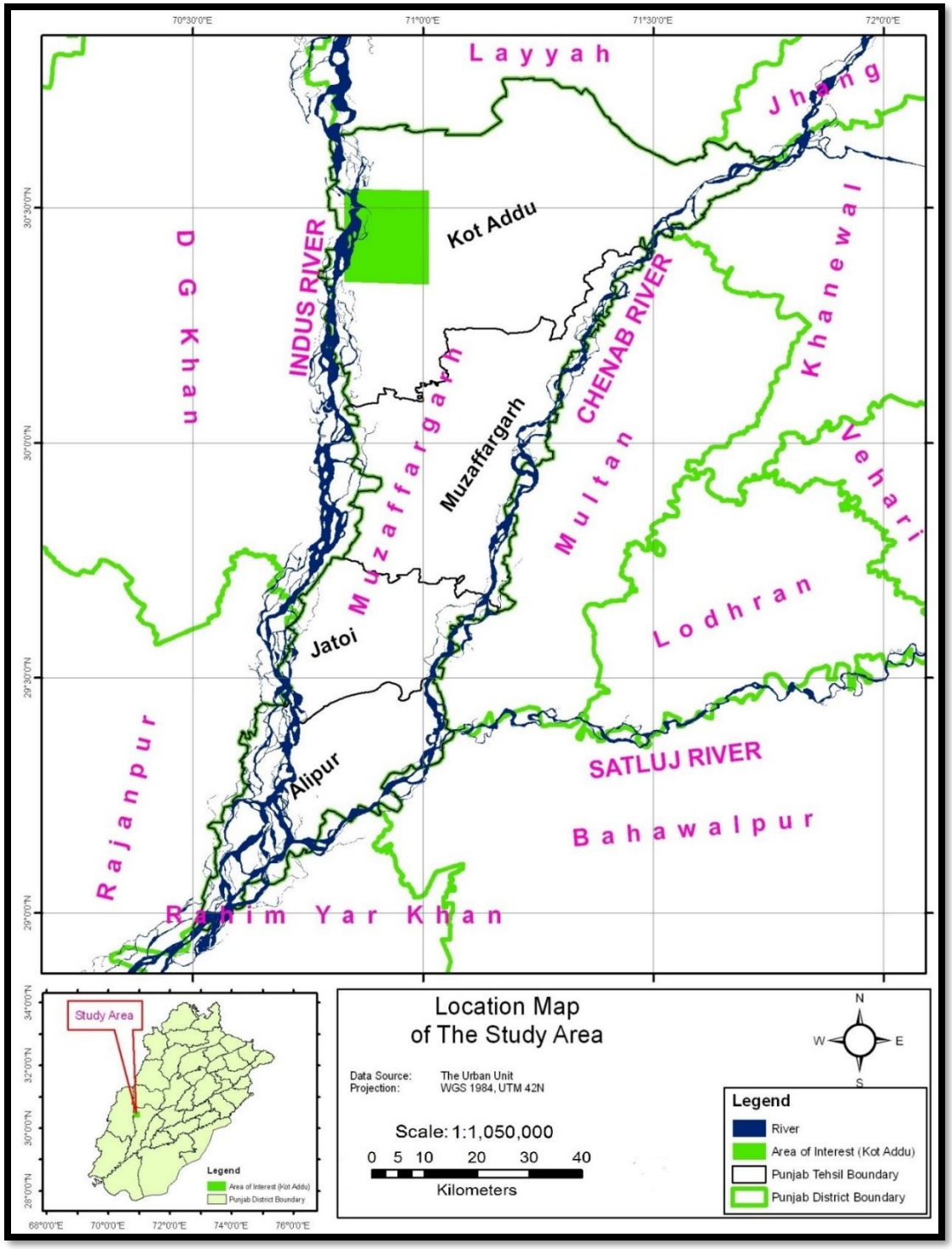


Figure 2: Location Map of Study Area

Methodology

The data was provided by the Digital Globe in patches. The mosaicking process was performed in Erdas Imagine to form a single scene of the WorldView-2 imageries. Moreover, the panchromatic image was diffused with multispectral imagery to get more clarity and high quality for visual interpretation. To identify the damaged features, visual interpretation technique is performed by using FCC on the multispectral 8-band imagery of spatial resolution 1.86m and compare with WorldView-2 panchromatic imagery of spatial resolution 0.46m, Quick Bird scenes of spatial resolution 0.6m along with digital photographs. About 170 categories of different LULC were identified using supervised classification on the basis of training areas and further recoded into 13 broad categories. GPS coordinates and the digital photographs of these damaged roads, drainage network, abadies, education institutes, health units, bridges, different kinds of agricultural and water areas were obtained during the field survey for verification of land use classification. The methodology flow chart is given in figure 3. The thematic map of training/samples points with WorldView-2 multispectral imagery is shown in the form of figure 4.

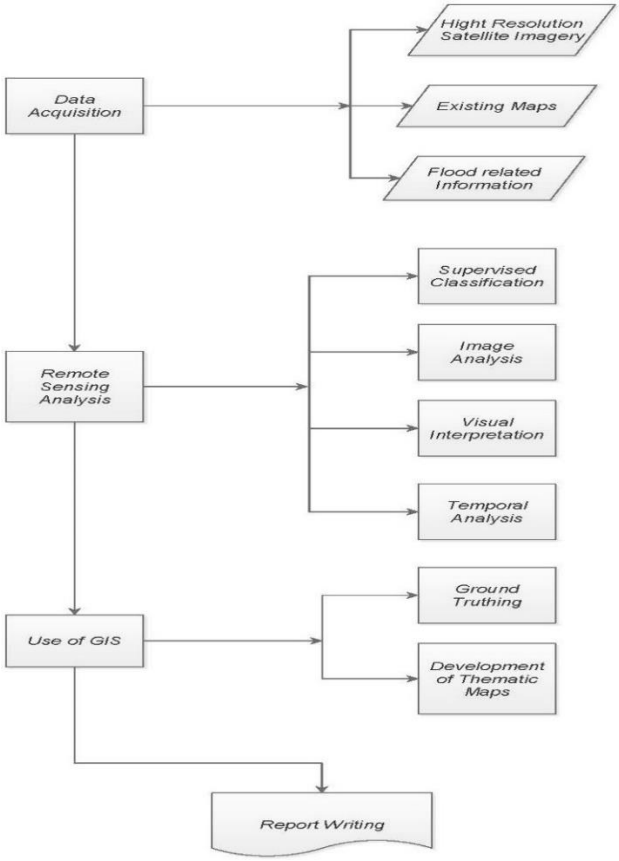


Figure 3: An Overview of the Methodology

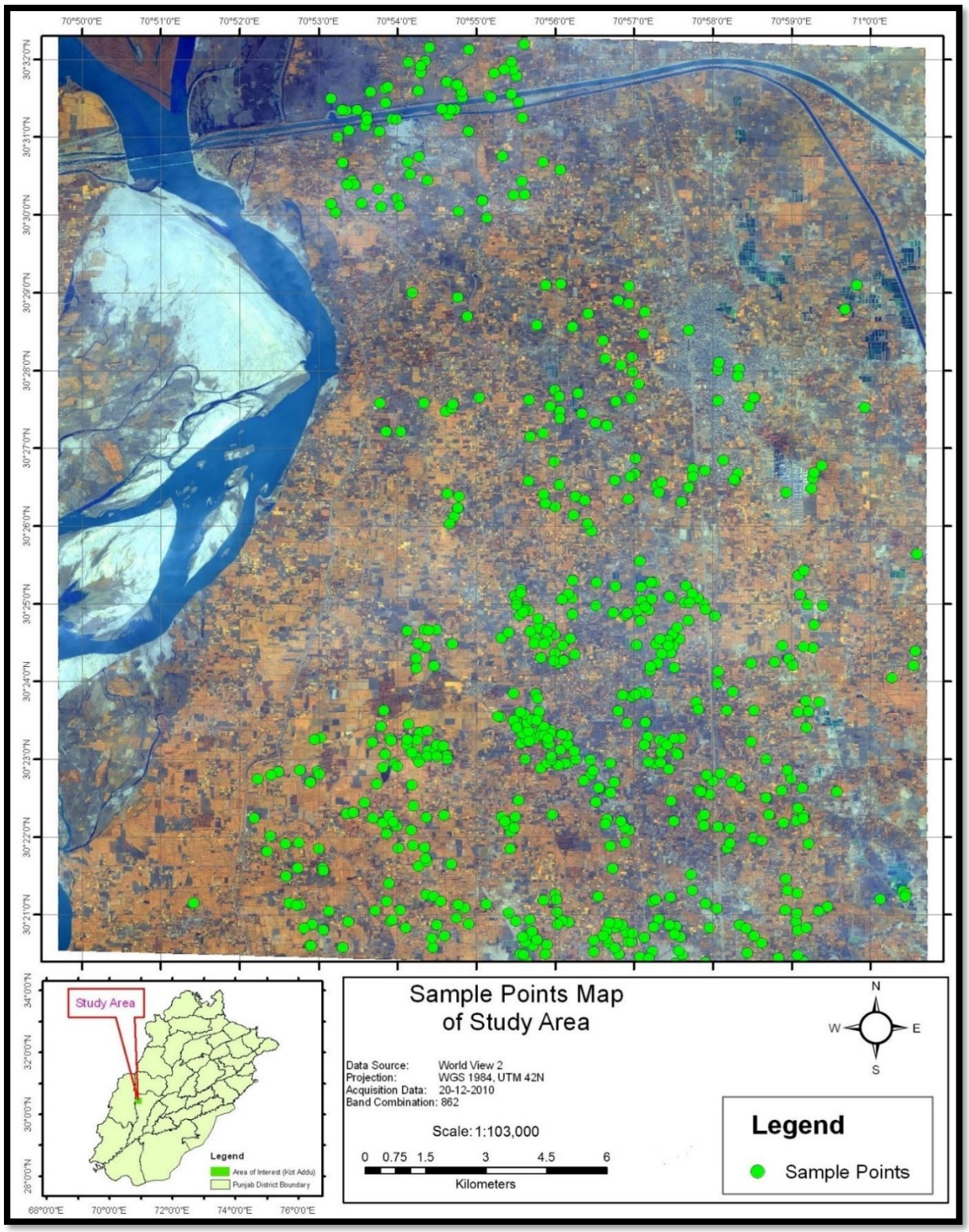


Figure 4: Training/Sample Points Map on the WorldView-2 Multispectral Image in FCC

Results and Discussion

Supervised classification was executed with the help of the sample points which were collected during the field survey. By using coastal blue band, the deep water and the sedimented water is identified. Yellow and Red-Edge spectral bands have the major role in identification of different kinds of the agriculture field. Even by using NIR2 spectral band, the damaged agriculture field is identified which has the dominant area than the other classes. Riverine forest, sparse forest, plantation/orchards, land soil and built-up areas are also identified in the classification results. About 13 classes during supervised classification results are shown in the thematic map as in figure 5. The area wise detail of the 13 classes is shown in the table 3.

Table 3: Supervised Classification Result

Sr. No.	Class Name	Area (Hector)
1	Healthy Agriculture Fields	540.69
2	Harvested Fields	974.89
3	Damage Agriculture Field	16900.96
4	Ploughed Fields	3684.62
5	Plantation/Orchards	455.03
6	Sparse Riverine Forest	44.52
7	Dense Riverine Forest	190.34
8	River Bed	2385.81
9	Land Soil	2070.64
10	Wet Land	7330.79
11	Deep Water	440.79
12	Sedimented Water	2088.99
13	Built-up	1805.78
	Total	**38913.87**

The result show that 16900.96 Hectors area out of 37108 Hectors was damaged agriculture land which is highest than the harvested field, healthy agriculture and ploughed field, while Sparse Riverine Forest has the area 44.52 hectors.

6.2: Visual interpretation

Visual interpretation technique is used to identify the damaged features using FCC on the multispectral 8-band imagery of spatial resolution 1.86m which was compared with WorldView-2 panchromatic imagery of spatial resolution 0.46m, Quick Bird scenes of spatial resolution 0.6m.

The direct tangible damages and intangible damages were observed by the flood 2010. Direct tangible damages include the physical damage of the houses and infrastructures, while intangible damages include the health impacts; physical and mental impacts. The different

tangible damaged features; school, village, road, agriculture, bridge, and irrigation channel are shown in figures 6,7, 8, 9, 10, 11 and 12. The school is worst damaged during the flood 2010 as shown in figure 7 (a, b, c and d). Village is highlighted in the figure 8 (a, b, c and d), which is also badly affected during the flood 2010. The infrastructure was consist of; road, bridge and irrigation channel are also badly affected during the flood 2010. The significance of the flood can be seen in such kind of visual interpretations. The crops were badly affected in flood 2010 which is shown in the figure 10 (a, b, c, and d). The standing flooded water can be seen in digital photograph.

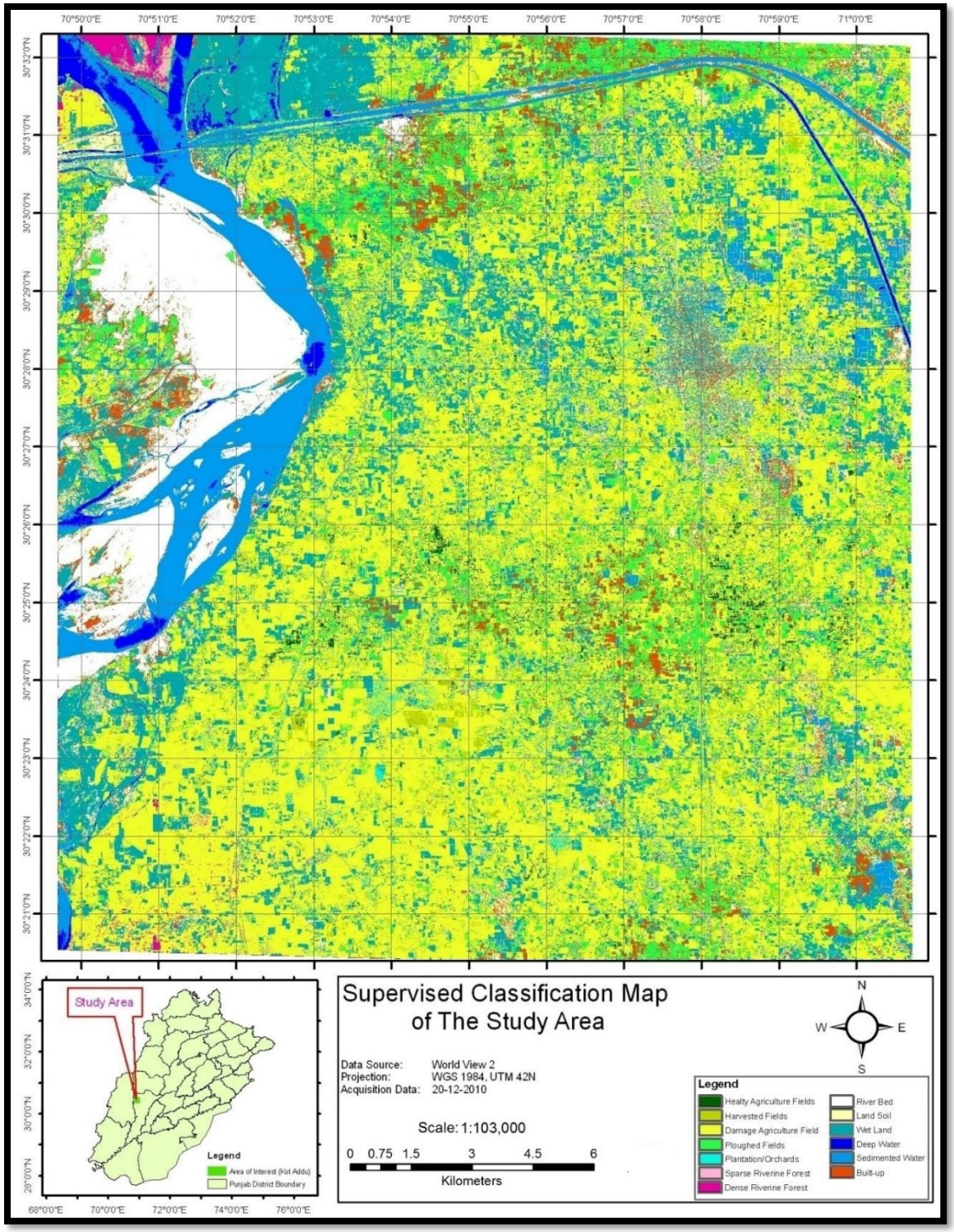


Figure 5: Supervised Classification Map

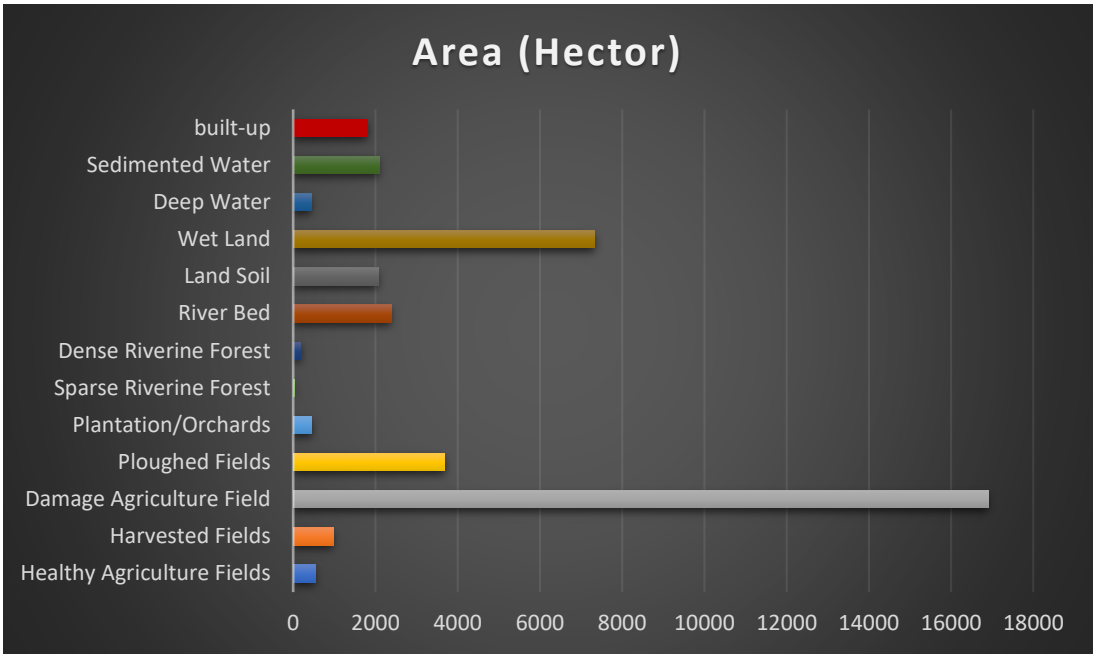


Figure 6: Supervised Classification Chart

In case of intangible damages through flood 2010, only 2 persons died and 35 persons were injured while 2127 cattle head lost in district Muzaffargarh according to PDMA reports [36,37,38,39].

Rehabilitation

In order to develop rehabilitation model for the flood affected infrastructures, damage houses and crops, the provincial government and federal government took initiative and compensated the losses of the flood affected people. The provincial government repaired the flood affected infrastructures (road, school, irrigation channels, bridges, masjids, health clinics/dispensary, tube wells, etc) and prepared the model villages for the flood affected people as shown in figure 13. The houses in the model villages were allotted after the verification to the flood affected people. The school, dispensaries, tevta centers, livestock shed/veterinary dispensary, park and community center are also included.

Now National Disaster Management Authority (NDMA), Provincial Disaster Management Authority (PDMA), Irrigation Department, Planning & Development department and district level government are planning to maintain the disaster response plans, risk vulnerability assessment and preparing the spatial decision support system (SDSS) to mitigate the rehabilitation activities before future flood.

(a) World View-2, Multispectral
Band Combination: 8, 6, 2
Date Acquisition: 20-12-2010

(b) World View-2, Panchromatic
Date Acquisition: 20-12-2010

(c) Pictorial View

(d) Quick Bird, 0.6m
Date Acquisition: 21-10-2009

Figure 7: Damaged GGPS, Shauhrat wala UC 1 School Building is shown temporally in a, b, c and d

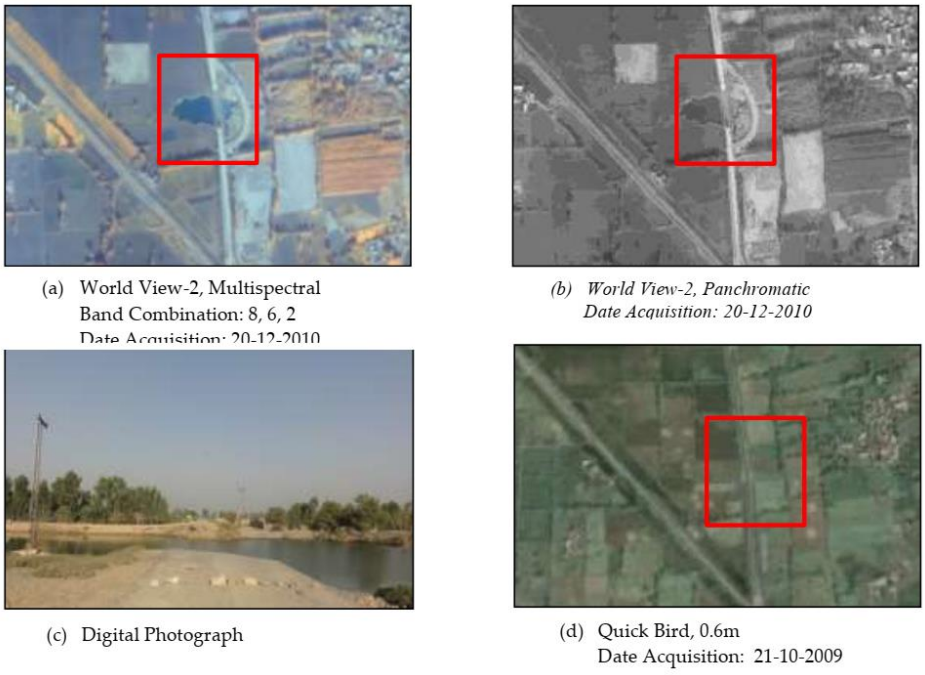
(a) World View-2, Multispectral
Band Combination: 8, 6, 2
Date Acquisition: 20-12-2010

(b) World View-2, Panchromatic
Date Acquisition: 20-12-2010

(b) Digital Photograph

(d) Quick Bird, 0.6m
Date Acquisition: 21-10-2009

Figure 8: Damaged Basti Korai Wala is shown temporally in a, b, c and d and d



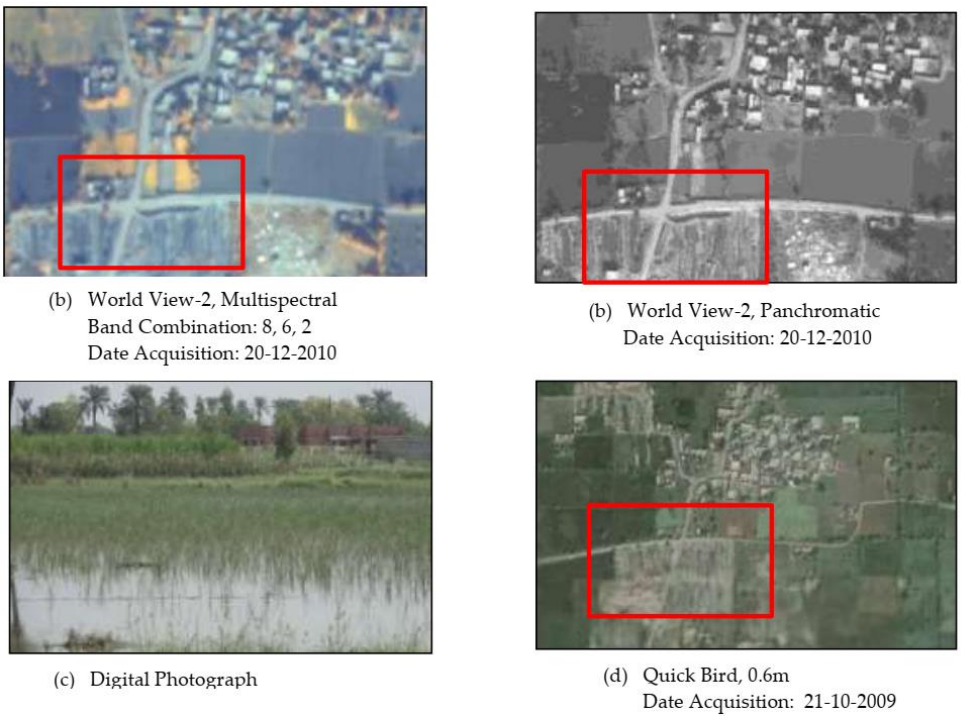
(a) World View-2, Multispectral
Band Combination: 8, 6, 2
Date Acquisition: 20-12-2010

(b) *World View-2, Panchromatic*
Date Acquisition: 20-12-2010

(c) Digital Photograph

(d) Quick Bird, 0.6m
Date Acquisition: 21-10-2009

Figure 9: Damaged Taunsa Road is shown temporally in a, b, c and d



(b) World View-2, Multispectral
Band Combination: 8, 6, 2
Date Acquisition: 20-12-2010

(b) World View-2, Panchromatic
Date Acquisition: 20-12-2010

(c) Digital Photograph

(d) Quick Bird, 0.6m
Date Acquisition: 21-10-2009

Figure 10: Damaged Agricultural at Haala village is shown temporally in a, b, c and d

(c) World View-2, Multispectral
Band Combination: 8, 6, 2
Date Acquisition: 20-12-2010

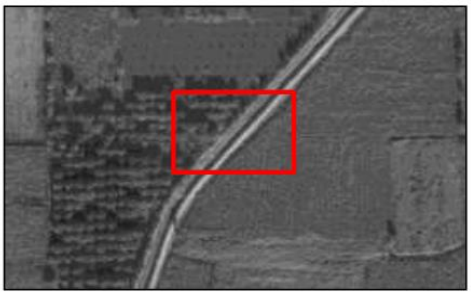
(b) World View-2, Panchromatic
Date Acquisition: 20-12-2010

(c) Digital Photograph

(d) Quick Bird, 0.6m
Date Acquisition: 21-10-2009

Figure 11: Damaged Bridge is shown temporally in a, b, c and d

(d) World View-2, Multispectral
Band Combination: 8, 6, 2
Date Acquisition: 20-12-2010



(b) World View-2, Panchromatic
Date Acquisition: 20-12-2010

(c) Digital Photograph

(d) Quick Bird, 0.6m
Date Acquisition: 21-10-2009

Figure 12: Damaged Irrigation channel is shown temporally in a, b, c and d

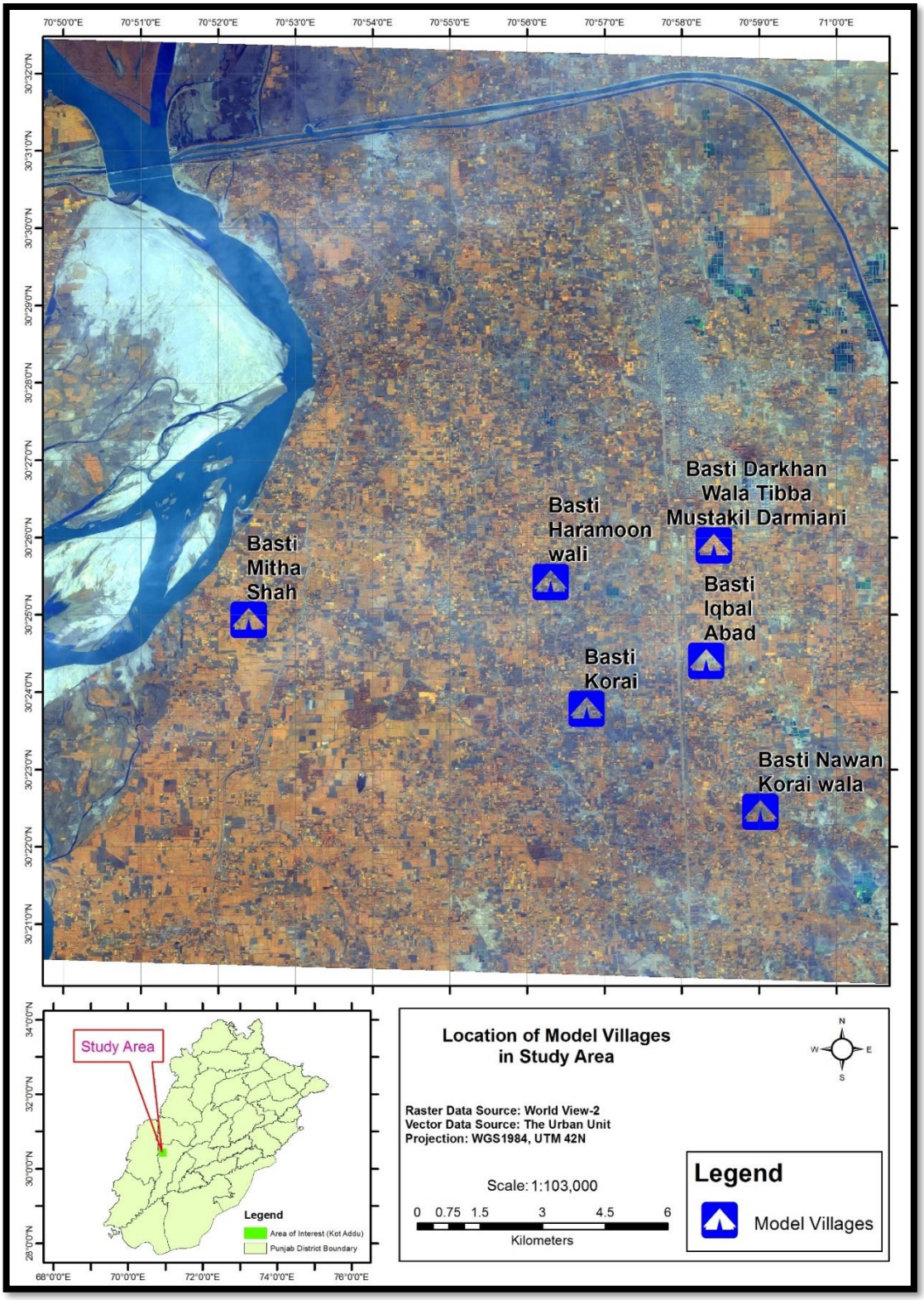


Figure 13: Location Map of Model Villages in Study Area

Conclusions

For disaster rehabilitation plan, it is of great importance to obtain classification results with precision. Worldview-2 multispectral image has the great potential to identify the existing landuse features by using the extra 4 bands besides its high spatial resolution. This imagery can be used for various application and obtain a fruitful result by using this study for different application related to natural disaster estimation, assessment, management, and redevelopment of affected areas. The combination of 8, 6, and 2 was found to be useful for flood related application. It made the differentiation of vegetation gone under water very clear. The red edge band and NIR2 enhanced the vegetation even under water and on the other hand blue band helped to identify water in fields. The visual interpretation of the affected area also worked well. The settlements and agricultural lands were efficiently mapped. The implementation of coastal blue band helped to identify the sedimented water in comparison to the deep blue water during supervised classification.

Limitation of the study

The study focuses on the damage assessment of the flood affected area in 31st July 2010 to 27th August 2010. To properly analyze the pre-flood and post flood situations of the area, a temporal imagery from world view-2 was required. Due to non-availability of the pre-flood imagery, an imagery of 0.6 m from the quick bird is used for temporal analysis.

Further Implications

8-band imagery has good capacity to identify the damage features, vegetation analysis, and water analysis by using extra 4 bands. So, disaster management specifically flood can be efficiently mapped on al large scale, e.g., whole Punjab province after flood.

Acknowledgement

I am thankful to The Urban Unit, P&D Department, Government of the Punjab, Lahore, Pakistan who provided me full support to accomplish my study work and to the Digital Globe for provision of sample satellite imagery of Worldview-2. I am also thankful to my supervisor, colleagues and friends who helped me in putting forward my research.

Conflict of interest : We declare no conflict of interest for publishing this research paper in IJIST.

Author's Contribution. All authors contributed equally.

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