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GIS Based Mappingof the Dams of Khyber Pakhtunkhwa (KPK) and Federally Administered Tribal Areas (FATA) For Promoting Fish Culture in Pakistan

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Abstract: As dams are most commonly used for drinking, irrigation, electricity generation and fish culturing purposes throughout the world, therefore, the present study was conducted the GIS based mapping of the large and small dams and reservoir to assess the potential dams for development of freshwater aquaculture in Province Khyber Pakhtunkhwa (KPK) and Federally Administered Tribal Areas (FATA) of Pakistan. The obtained results of the present study willprovidenew information about the large and small dams and reservoir of KPK and FATA regarding the dam's name, coordinates, height, status, purpose, elevation, storage capacity etc., that will be very helpful for theresearchers and fish culturists in future to see the penalty of their need to locate a new production unit at any particular district, in terms of dam's latitude, longitude, status, dam's height, water depth, quality, hydrodynamics, existing dam locations and benthic fauna to support the preparation of aquaculture strategies and development plans that later will also contribute in the economy of the nation. Such information's could also be valuable for determining the growth rate and productivity of fishes that could be valuable in the systematic, fisheries management and conservation to further improve the ecological setup necessary for growing fish.

Key words: Dams · KPK · FATA · Fish Fauna · GIS Mapping

INTRODUCTION

Dam construction is not new work;even the ancient people have been built dams since thousands of years for various purposes such as, drinking water, irrigation, floods control as well as for electricity generation purposes. Over the last six decades, about half of the World Rivers contain at least one large dam constructed on them. More than 50% of the electricityhad been generated from the dams in third world countries and half of the large dams of the world were built primarily for the irrigation purpose [1]. The global Water system project collaborate the Earth system science partnership started to collect the world dam and reservoir dataset, that is "The global reservoir and Dam database (GRanD)", which are providing reliable data of characteristics and geographical distribution of Dams and reservoirs. The GRanD have 6862 records of dams and reservoirs,but this database contains only large dams and reservoirs records.

Dams in Khyber Pakhtunkhwa (KPK) province and Federally Administered Tribal Areas (FATA) of Pakistan can also be considered as importantsources for water supply. All these dams were built to prevent areas from flooding to prevent loss of property by floods and serve as for recreation or tourism. These dams are not only used for irrigation, drinking, domestic and electricity generating purposes but the physical and chemical characteristics of these fresh water reservoirs had been found to be suitable

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to support a unique biodiversity of flora and fauna consisting of many aquatic plants, invertebrates and vertebrate fauna including various freshwater fish species that are commonly used as nutritionally rich food for local populations. Therefore, many researchers had made an important contributions to provide the distributions of fish fauna found in dams, streams and other freshwater reservoirs of KPK and FATA areas in recent past including Hussain and Shah [2]who reported six fish species from River Swat; Ahmad and Mirza [3] also observed 8 species of including two new Loaches from Swat, Butt [4] recorded 94 fish species of fishes from the whole province of Khyber Pakhtunkhwa; Nisar [5] observed 23 species from Tanda Dam of district Kohat, Shahjehan and Khan [6] studied 26 species from BaranDam of Bannu district. More recently, about 18 species have been discovered from River Swat by Ishaq *et al.* [7] and eleven fish species from River Panjkora at District Dir Upper [8], 20 species from River Arunai Matta, Swat Districtby Akhthar *et al.* [9] and eleven species from Tanda Dam of Kohat district were reported by Haseeb *et al*. [10].

As GIS mapping technology is now proved to be useful modern techniques that can provide guidance, direction of any study area and now serve as an essential information source for every day. Therefore, present paper was conducted to provide the geographical distribution and information about the large and small dams and reservoir of KhyberPakhtunkhwa province and FATA areas of Pakistan. These dams mapping have been given in order to help the researchers for future research and provide additional information regarding the dam's name, coordinates, height, status, purpose, elevation, storage capacity etc. Through maps of any preferred dam, fish culturists can see the penalty of their need to locate a new production unit at any particular district, in terms of dam's latitude, longitude, status, dam's height and for main uses also.

MATERIALS AND METHODS

Study Area: Khyber Pakhtunkhwa (KPK) is located in the north-west of Pakistan. It is bounded by Gilgit-Baltistan on the northeast, Punjab on the southeast and

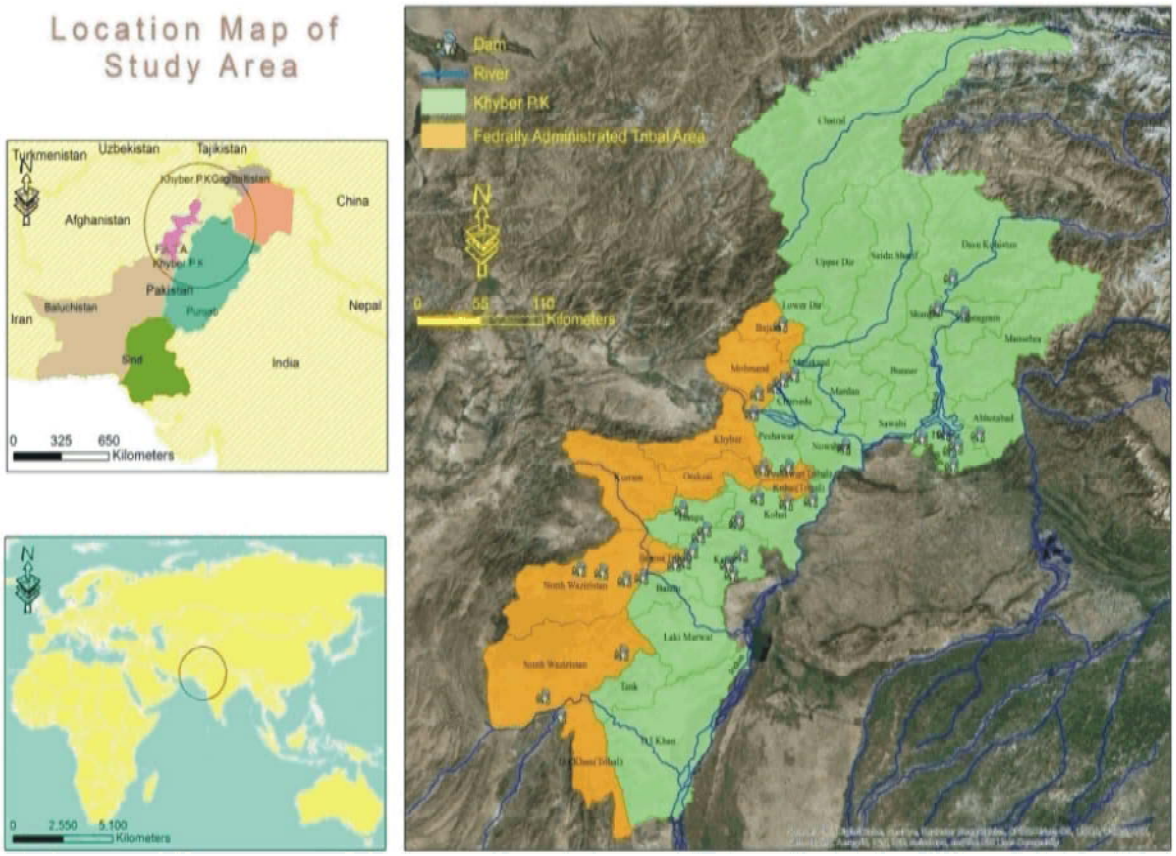


Fig. 1: Location Map of Study Area

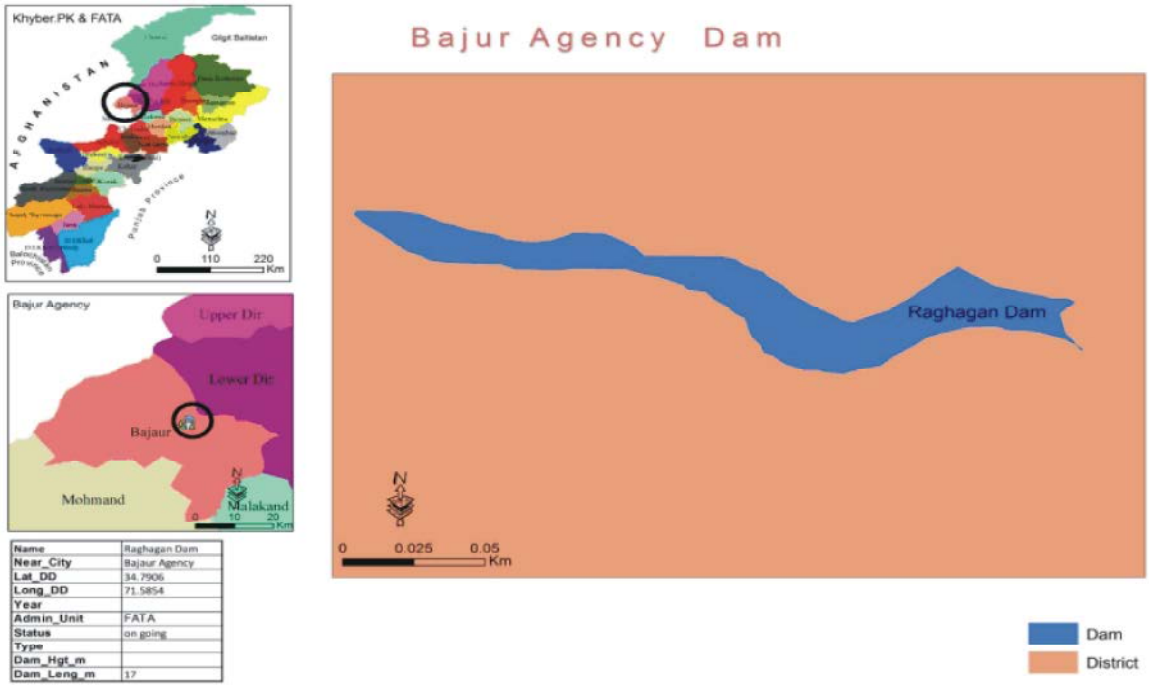
Azad Kashmir on the east (Figure 1). A narrow strip of land belonging to the Federally Administered Tribal Areas (FATA) borders it to the south and directly below that is Balochistan. Its total area is 74,521 Km^2, has a population of over 22 million. FATA (Federally Administered Tribal Areas) is spread over 27,220 Km^2 and has a population of 3,764,000. It comprises of seven Tribal Agencies and six Frontier Regions. The Tribal Agencies are Bajaur, Orakzai, Mohmand, Khyber, Kurram, North Waziristan and South Waziristan. The Frontier Regions includes F.R. Bannu, Central Kurram, F.R. Dera Ismail Khan, F.R. Kohat, F.R. Lakki, F.R. Peshawar and F.R. Tank [11].

GIS Mapping Technology: Present study collected the maximum information of dams from secondary sources, so, some dams have missing information. The dam's location identified and mapped using Google earth software and convert to kml format for preparation of layout in Arcmap 10.3 software.

RESULTS AND DISCUSSION

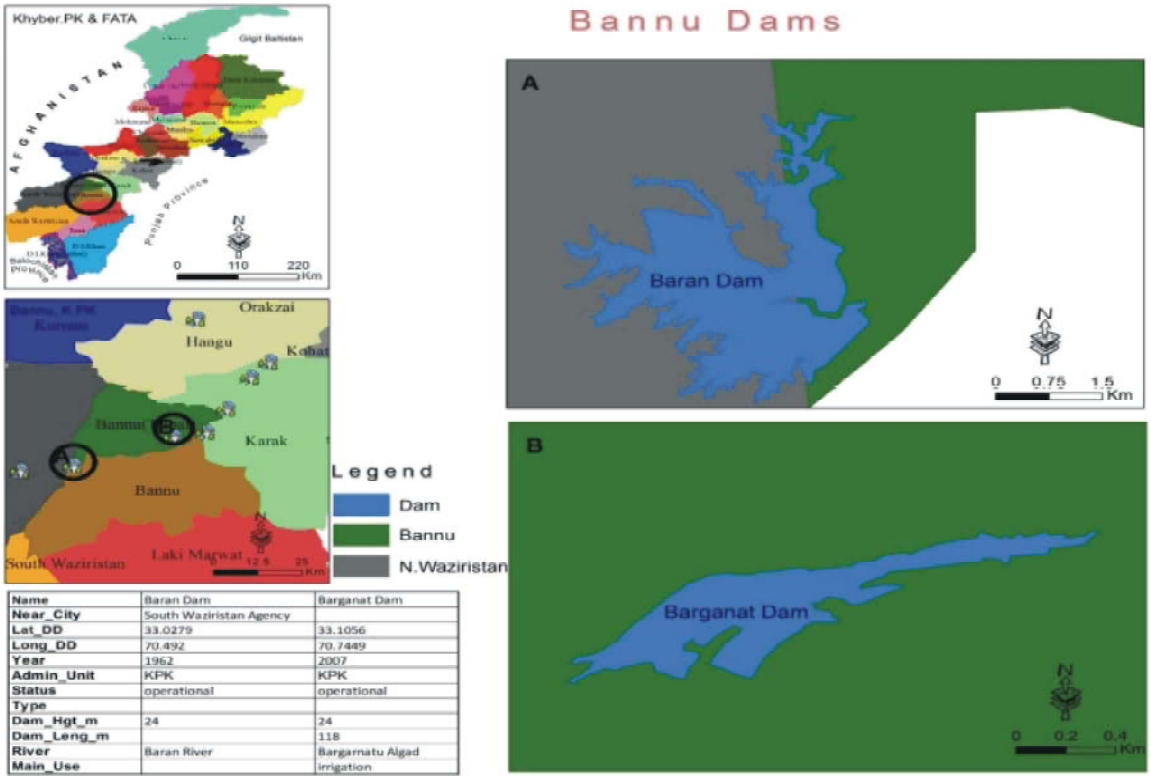
A geographical information system (GIS) is a computerized system that combines spatial and graphic data for mapping and investigation [12]. The term GIS is currently applied to computerized storage that have hardware and software specially designed to subsist with geographically referenced spatial data and relative informative impute [13]. A GIS tool can be used to produce not just maps but images, drawings, animations and other cartographic products.Today, local troubles also have a geographic constituent that can be visualized using GIS technology. Careful analysis of spatial data using GIS can give imminent into these problems and recommend ways in which they can be addressed [14]. Maps have a special place in GIS. The process of making maps with GIS is much easier than the old cartography approaches. Map projections are ways of transferring from a 3-D sphere (The globe) information to a 2-D plane (A piece of paper or a computer screen) accepting map projections are significant to anyone working with GIS because a three dimensional object cannot be represented perfectly in two dimensions. Some information must be distorted. Map projections allow the mapmaker to select which value should be potted in a map. The choice of map projection can affect not only the beauty of the map but also any analyses performed using that map.

There is significant possible to expand inland aquaculture in KPK and FATA to improve food security. To aid in development and management for aquaculture, GIS modeling techniques is used to identify and map specific sites for fish culturing and GIS tools can assist in allocating more land and water space for sustainable aquaculture expansion. A key issue in aquaculture



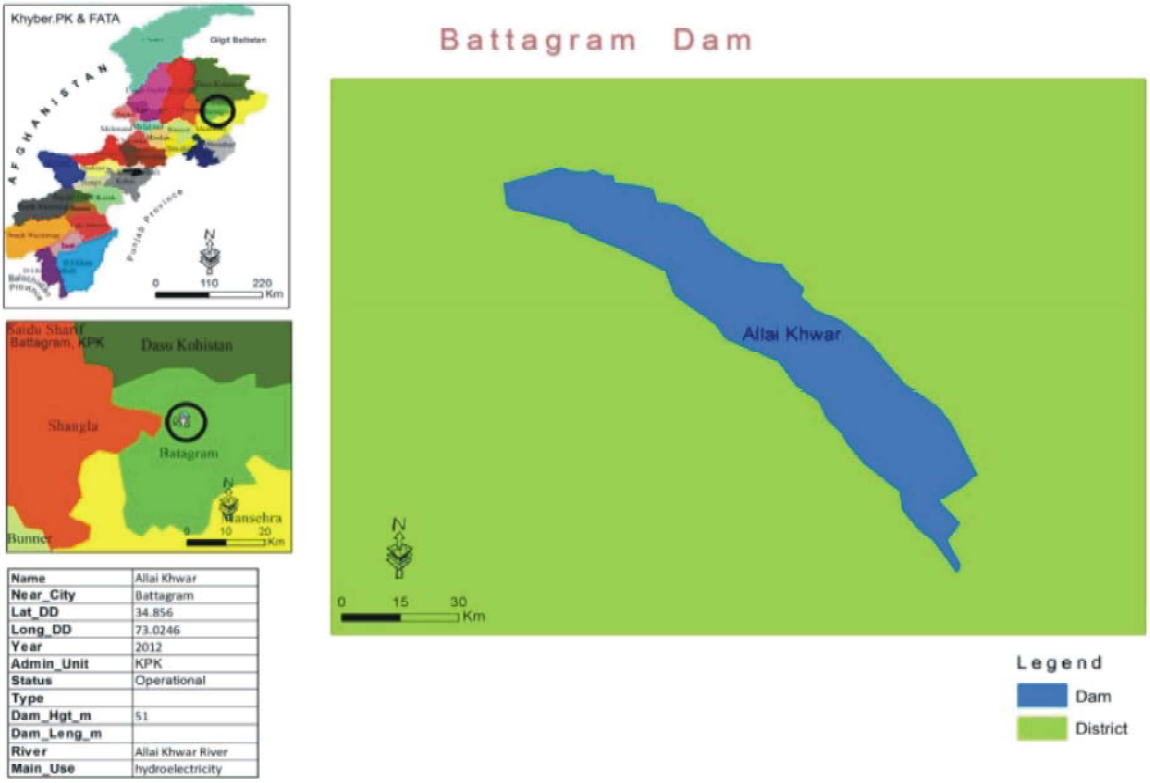
Name	Raghagan Dam
Near_City	Bajaur Agency
Lat_DD	34.7906
Long_DD	71.5854
Year	
Admin_Unit	FATA
Status	on going
Type	
Dam_Hgt_m	
Dam_Leng_m	17

Fig. 2: Raghagan Dam



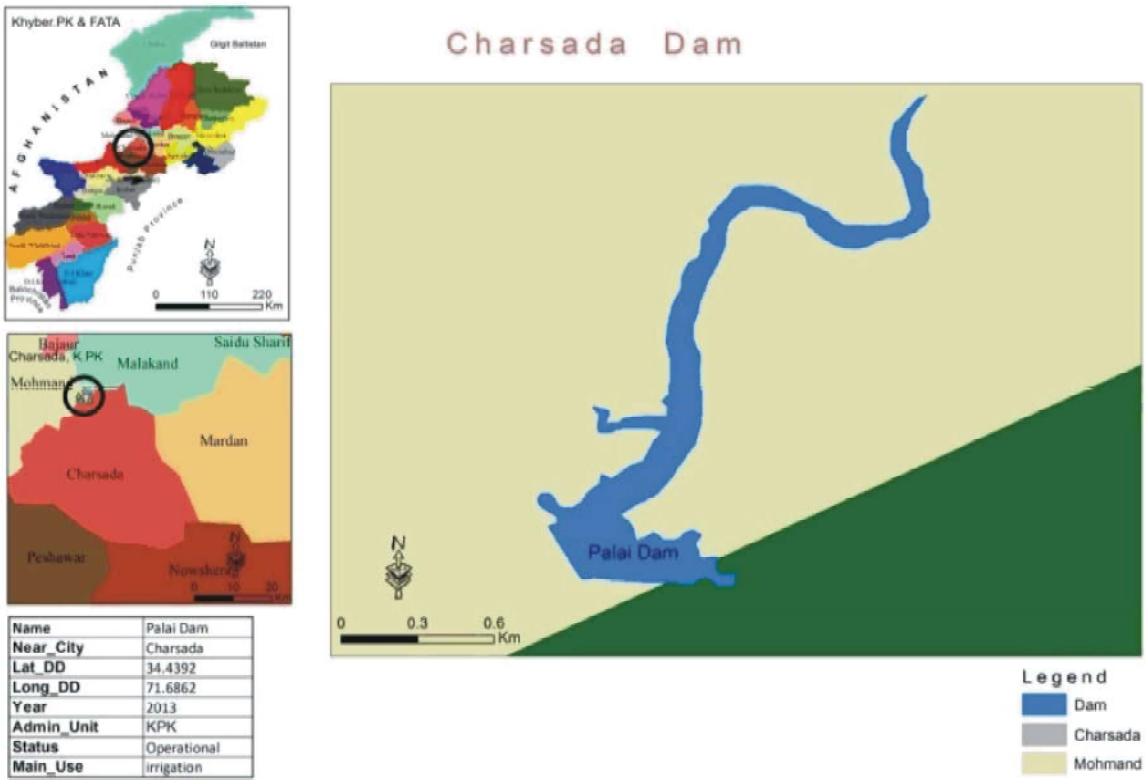
Name	Baran Dam	Barganat Dam
Near_City	South Waziristan Agency	
Lat_DD	33.0279	33.1056
Long_DD	70.492	70.7449
Year	1962	2007
Admin_Unit	KPK	KPK
Status	operational	operational
Type		
Dam_Hgt_m	24	24
Dam_Leng_m		118
River	Baran River	Bargarnatu Algad
Main_Use		irrigation

Fig. 3: Barran and Barganat Dams



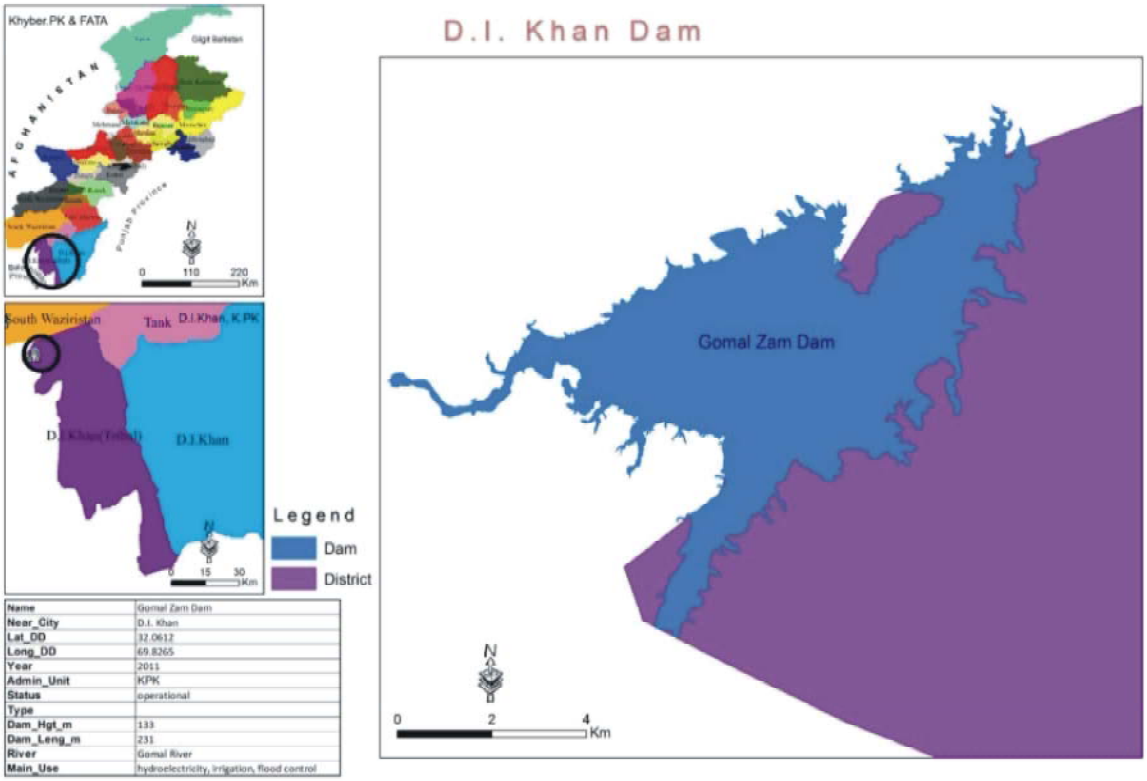
Name	Allai Khwar
Near_City	Battagram
Lat_DD	34.856
Long_DD	73.0246
Year	2012
Admin_Unit	KPK
Status	Operational
Type	
Dam_Hgt_m	51
Dam_Leng_m	
River	Allai Khwar River
Main_Use	hydroelectricity

Fig. 4: AllaiKhwar



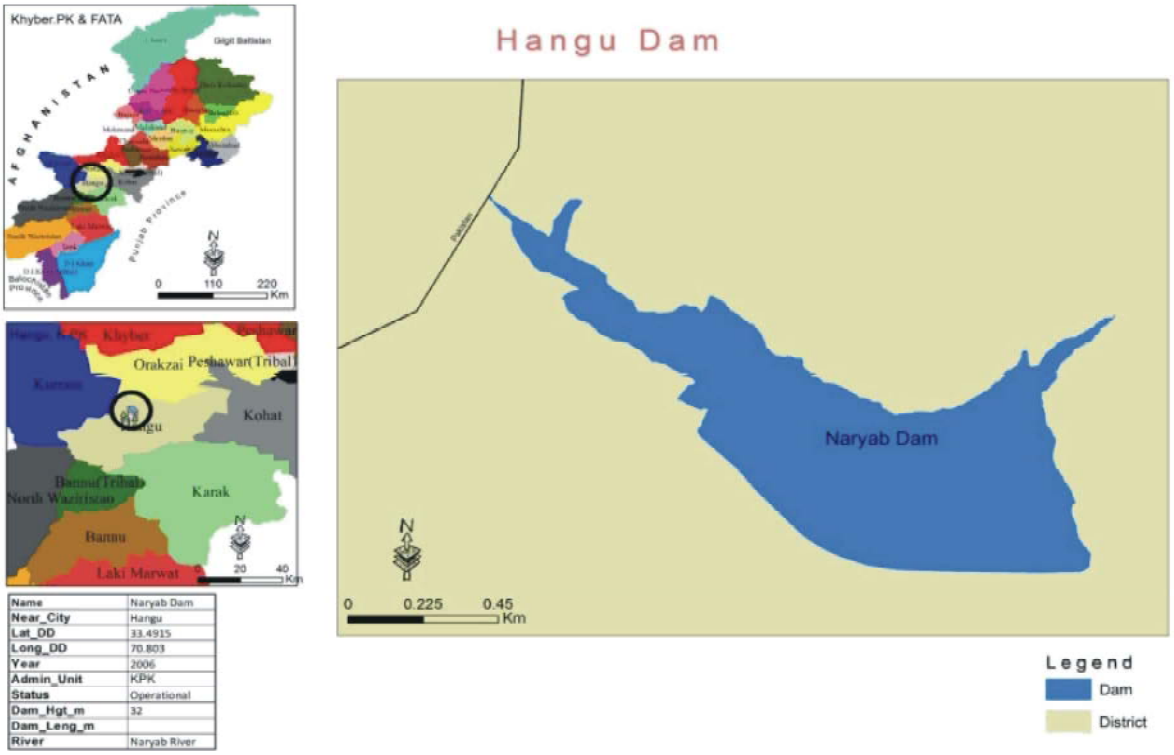
Name	Palai Dam
Near_City	Charsada
Lat_DD	34.4392
Long_DD	71.6862
Year	2013
Admin_Unit	KPK
Status	Operational
Main_Use	irrigation

Fig. 5: Palai Dam



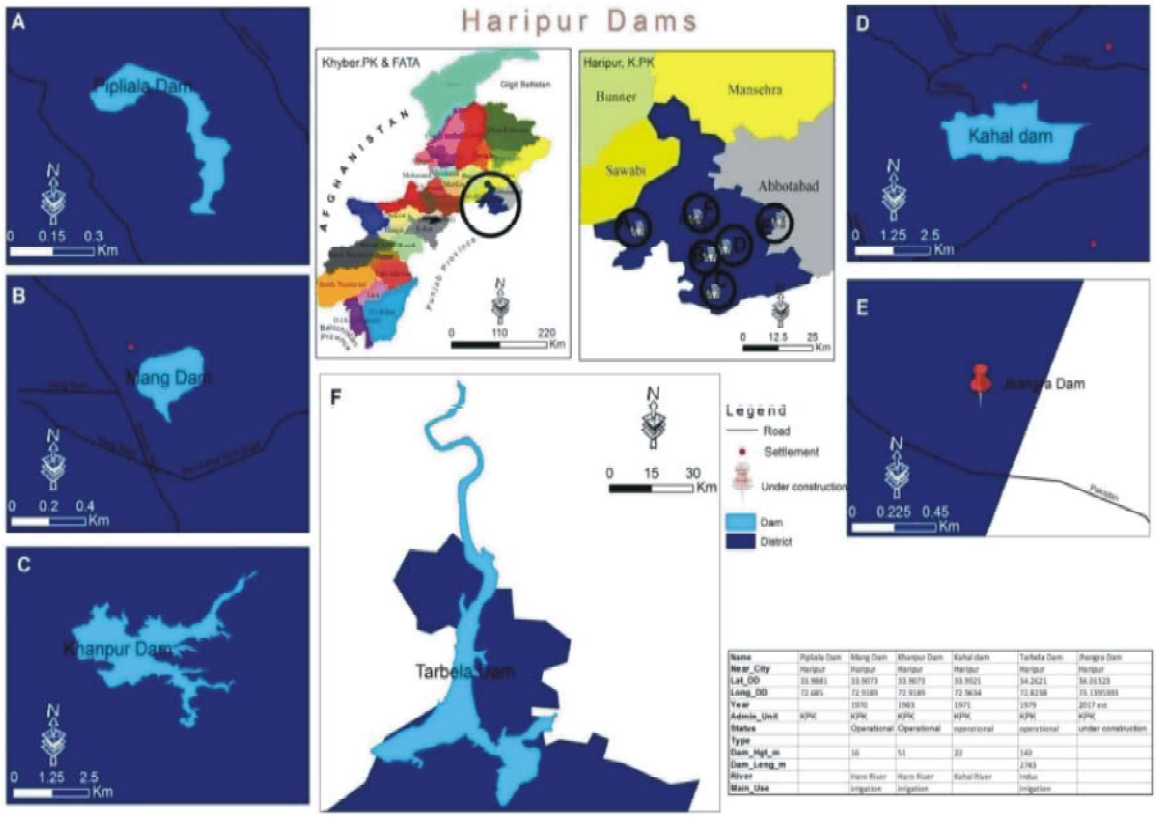
Name	Gomal Zam Dam
Near_City	D.I. Khan
Lat_DD	32.0612
Long_DD	69.8265
Year	2011
Admin_Unit	KPK
Status	operational
Type	
Dam_Hgt_m	133
Dam_Leng_m	231
River	Gomal River
Main_Use	hydroelectricity, irrigation, flood control

Fig. 6: Gomal Zam Dam



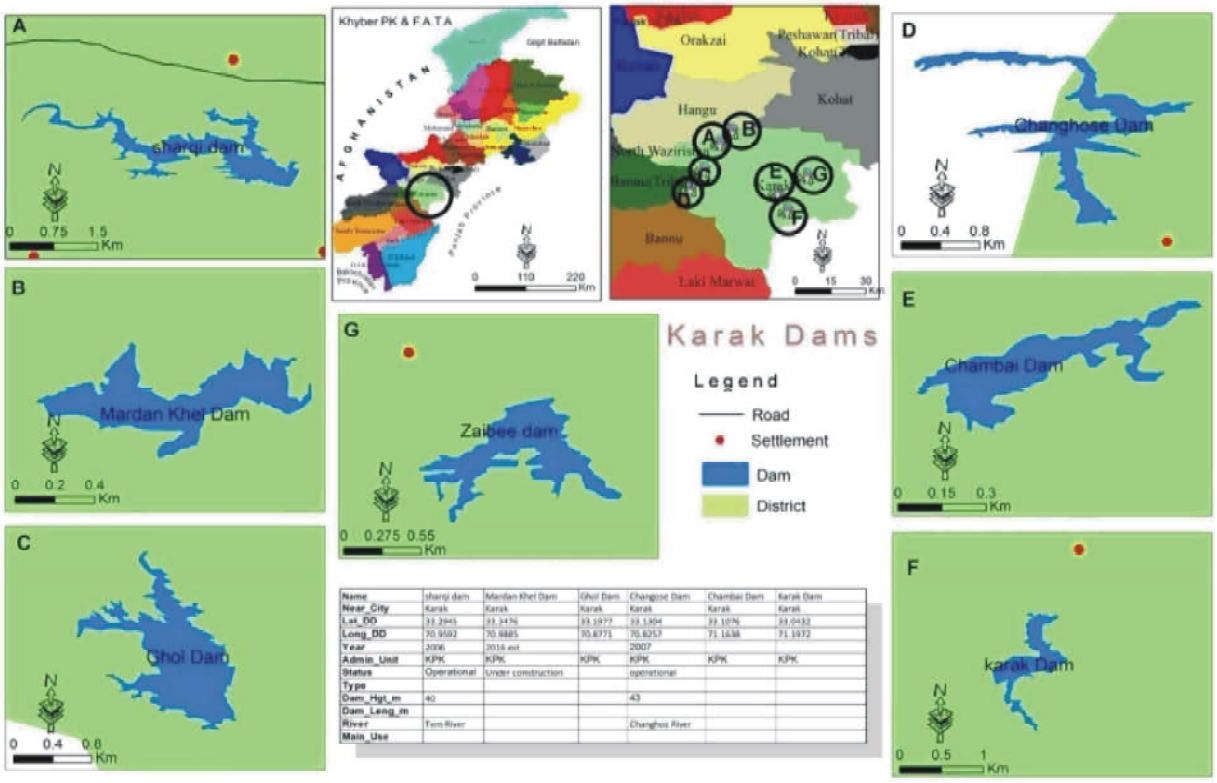
Name	Naryab Dam
Near_City	Hangu
Lat_DD	33.4915
Long_DD	70.803
Year	2006
Admin_Unit	KPK
Status	Operational
Dam_Hgt_m	32
Dam_Leng_m	
River	Naryab River

Fig. 7: Naryab Dam



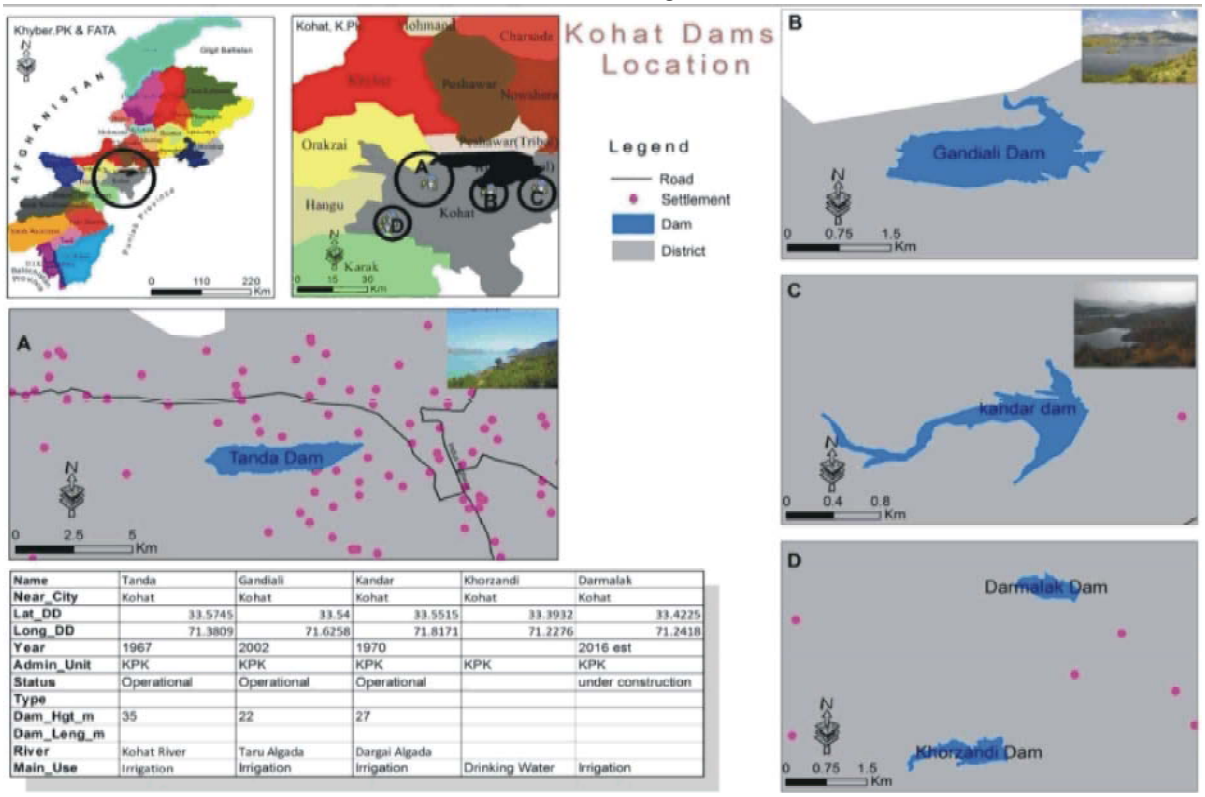
Name	Pipliala Dam	Mang Dam	Khanpur Dam	Kahal dam	Tarbela Dam	Jhangra Dam
Near_City	Haripur	Haripur	Haripur	Haripur	Haripur	Haripur
Lat_DD	33.9661	33.9073	33.9073	33.9521	34.2621	34.01323
Long_DD	72.685	72.9189	72.9189	72.9634	72.8238	73.1393889
Year		1970	1963	1971	1979	2017 est
Admin_Unit	KPK	KPK	KPK	KPK	KPK	KPK
Status		Operational	Operational	operational	operational	under construction
Type						
Dam_Hgt_m		16	51	22	148	
Dam_Leng_m					2743	
River		Haro River	Haro River	Kahal River	Indus	
Main_Use		Irrigation	Irrigation		Irrigation	

Fig. 8: Pipliala Dam, Mang Dam, Khanpur Dam, Khal Dam, Jhangra Dam



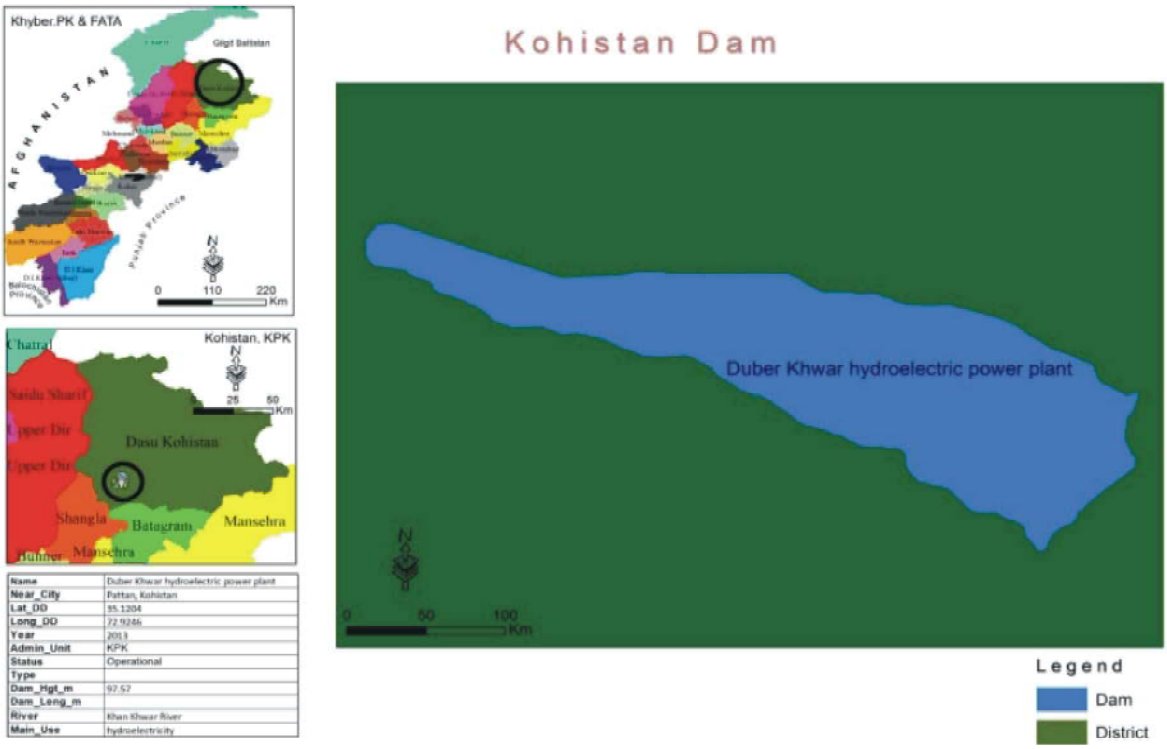
Name	sharqi dam	Mardan Khel Dam	Ghol Dam	Changhose Dam	Chambai Dam	Karak Dam
Near_City	Karak	Karak	Karak	Karak	Karak	Karak
Lat_DD	33.2945	33.3476	33.1977	33.1304	33.1076	33.0432
Long_DD	70.9502	70.9885	70.8771	70.8257	71.1638	71.1972
Year	2006	2016 est		2007		
Admin_Unit	KPK	KPK	KPK	KPK	KPK	KPK
Status	Operational	Under construction		operational		
Type						
Dam_Hgt_m	40			43		
Dam_Leng_m						
River	Tern River			Changhos River		
Main_Use						

Fig. 9: Sharki Dam, Mardankhel Dam, Ghol Dam, Zaibi Dam, Changhose Dam, Chambaiand Karak Dam



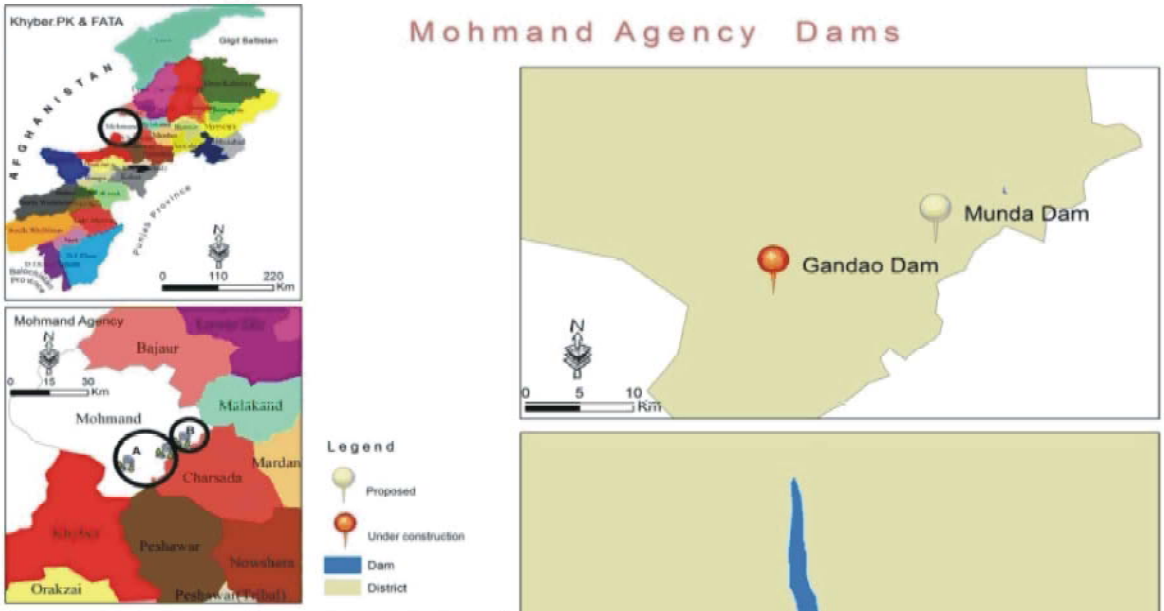
Name	Tanda	Gandiali	Kandar	Khorzandi	Darmalak
Near_City	Kohat	Kohat	Kohat	Kohat	Kohat
Lat_DD	33.5745	33.54	33.5515	33.3932	33.4225
Long_DD	71.3809	71.6258	71.8171	71.2276	71.2418
Year	1967	2002	1970		2016 est
Admin_Unit	KPK	KPK	KPK	KPK	KPK
Status	Operational	Operational	Operational		under construction
Type					
Dam_Hgt_m	35	22	27		
Dam_Leng_m					
River	Kohat River	Taru Algada	Dargai Algada		
Main_Use	Irrigation	Irrigation	Irrigation	Drinking Water	Irrigation

Fig. 10: Tanda Dam, Gandiali Dam, Kandar Dam, Darmalak Dam, Khorzandi Dam



Name	Duber Khwar hydroelectric power plant
Near_City	Pattan, Kohistan
Lat_DD	35.1204
Long_DD	72.9286
Year	2013
Admin_Unit	KPK
Status	Operational
Type	
Dam_Hgt_m	92.52
Dam_Leng_m	
River	Khan Khwar River
Main_Use	hydroelectricity

Fig. 11: Duberkhwar hydroelectric power plant



Name	Moto Shah Dam	Gandao Dam	Munda Dam
Near_City	Mohmand Agency	Mohmand Agency	Mohmand Agency
Lat_DD	34.3993	34.3041	34.30408
Long_DD	71.5905	71.3974	71.39801
Year	2012	2015 est	
Admin_Unit	FATA	FATA	FATA
Status	operational	Under construction	Proposed
Type			
Dam_Hgt_m	30	32	213
Dam_Leng_m	114	76	760
River			Swat River
Main_Use			multi-purpose

Fig. 12: Munda Dam, Gandao Dam, Moto shah Dam

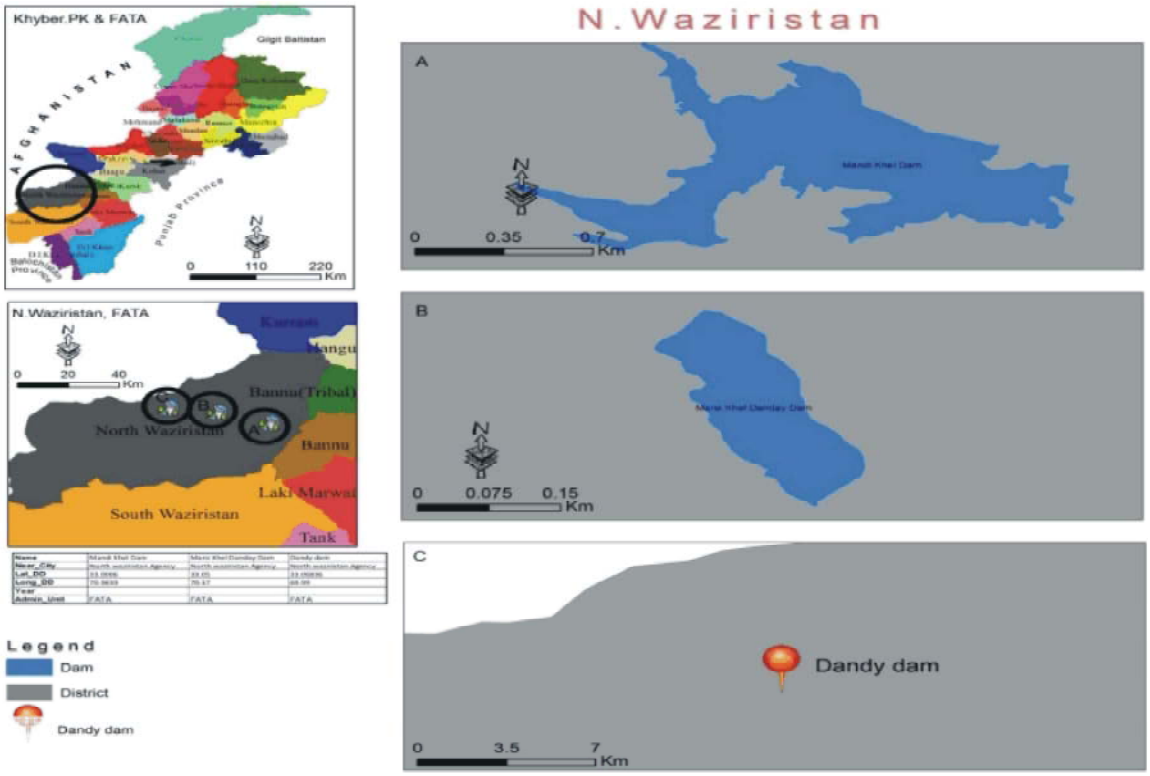


Fig. 13: Mandikhel Dam, Marsikhel Dandey Dam

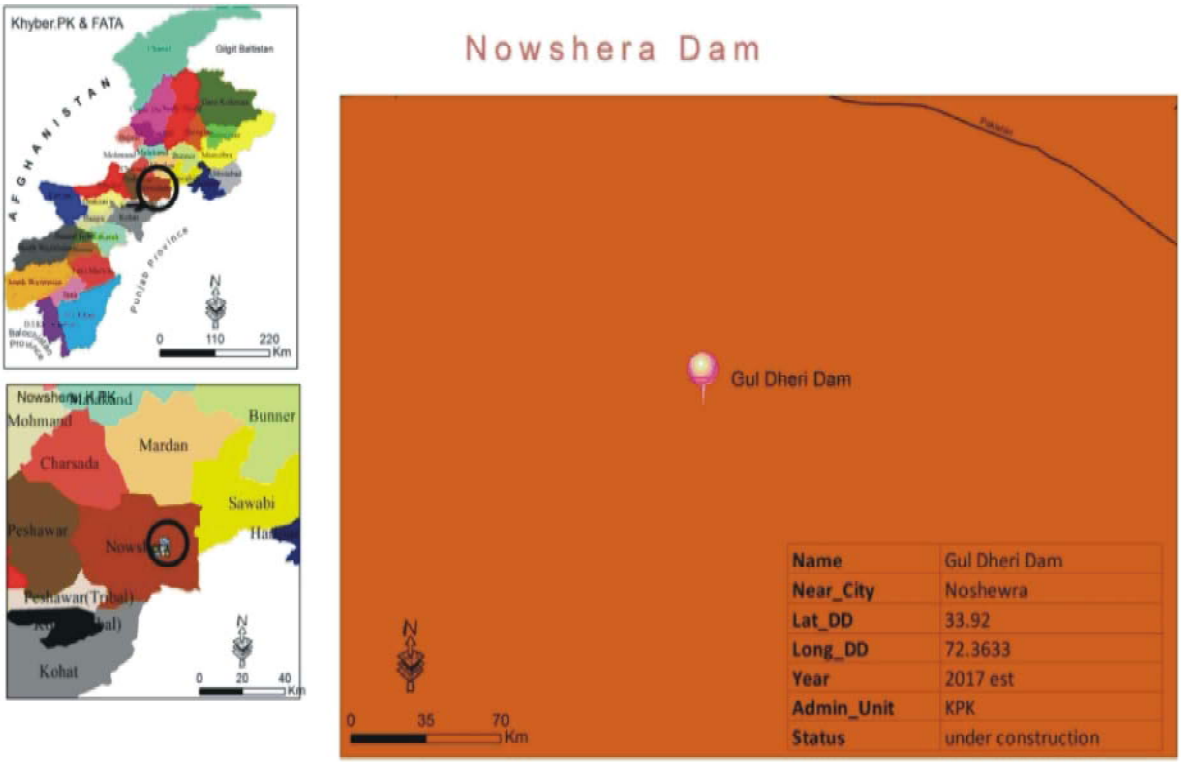
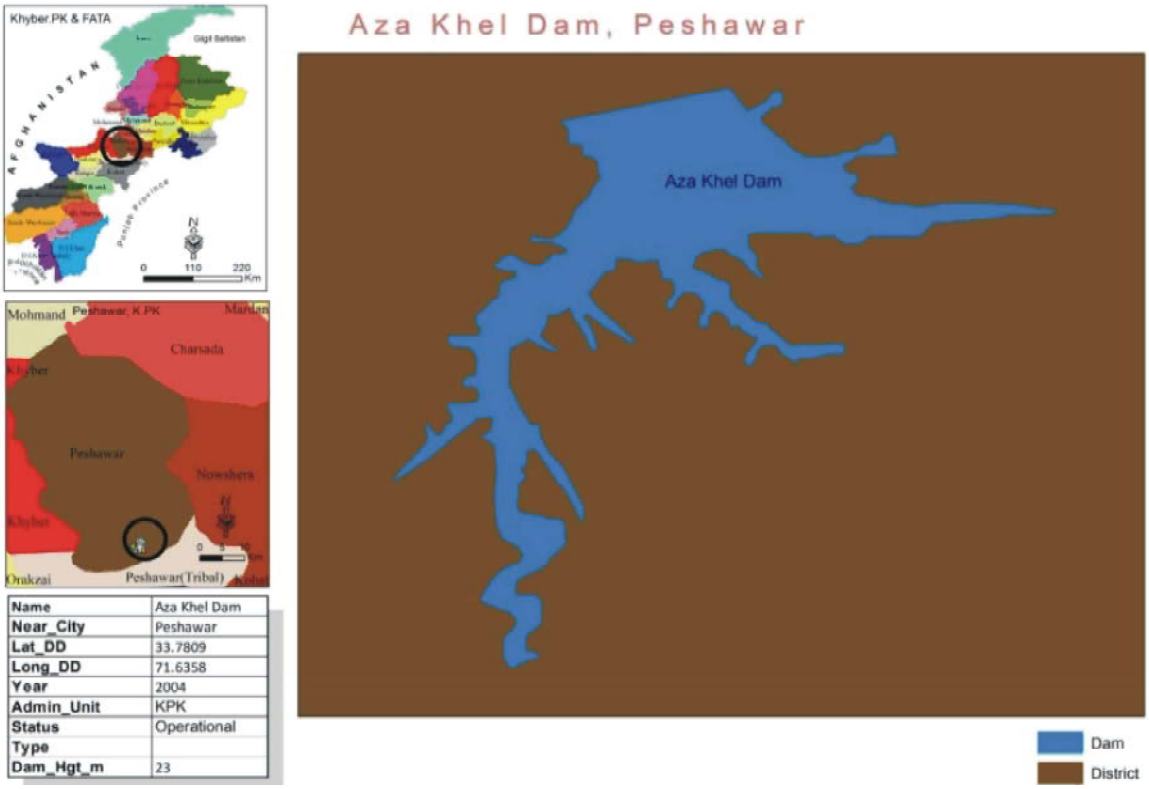
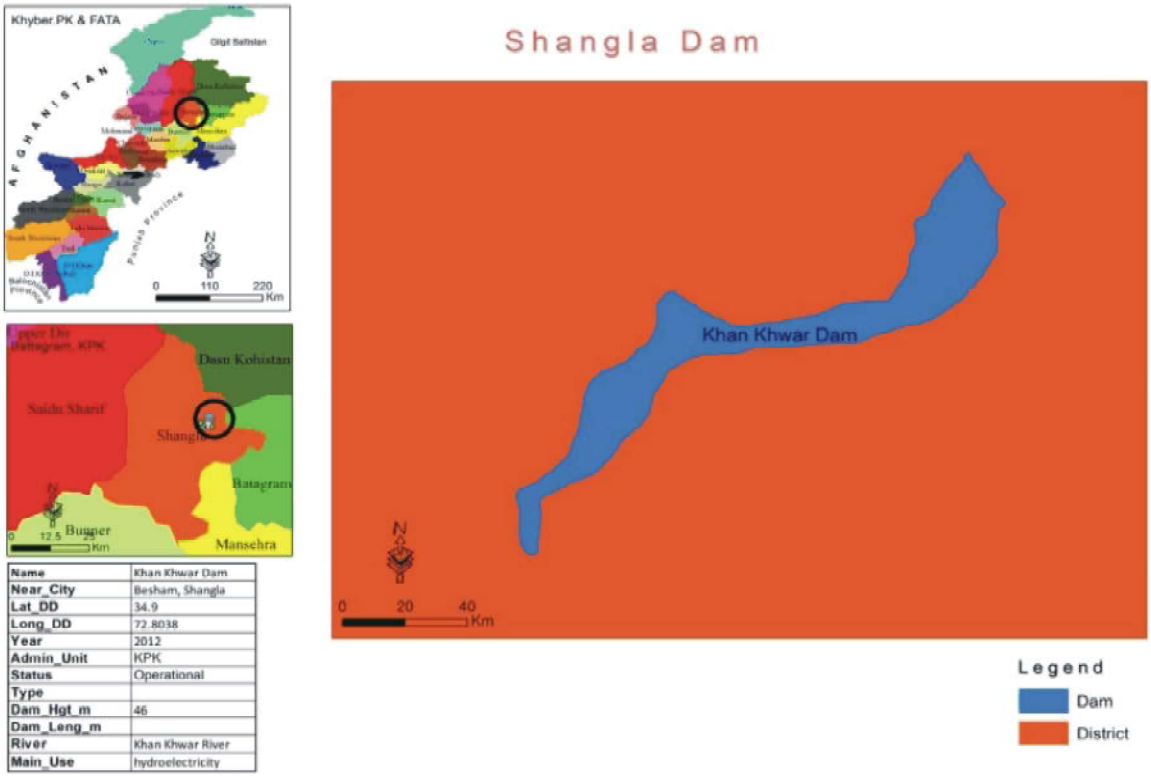


Fig. 14: Gul Dheri Dam



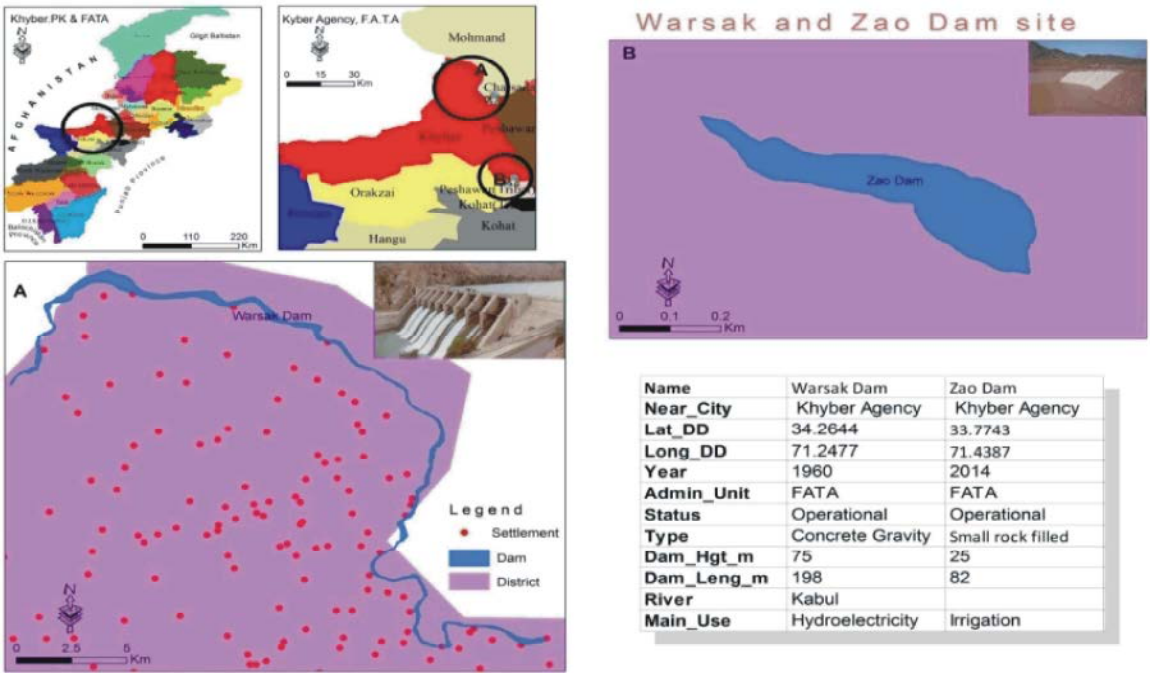
Name	Aza Khel Dam
Near_City	Peshawar
Lat_DD	33.7809
Long_DD	71.6358
Year	2004
Admin_Unit	KPK
Status	Operational
Type	
Dam_Hgt_m	23

Fig. 15: Aza Khel Dam



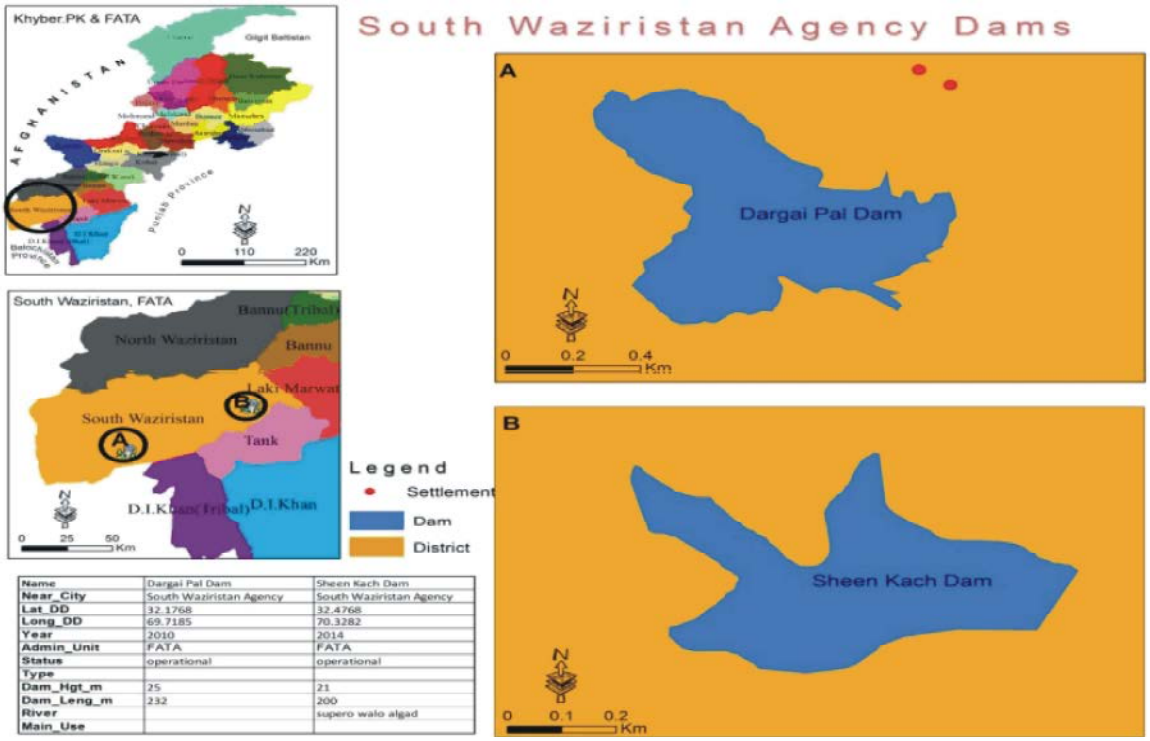
Name	Khan Khwar Dam
Near_City	Besham, Shangla
Lat_DD	34.9
Long_DD	72.8038
Year	2012
Admin_Unit	KPK
Status	Operational
Type	
Dam_Hgt_m	46
Dam_Leng_m	
River	Khan Khwar River
Main_Use	hydroelectricity

Fig. 16: Khan Khwar Dam



Name	Warsak Dam	Zao Dam
Near_City	Khyber Agency	Khyber Agency
Lat_DD	34.2644	33.7743
Long_DD	71.2477	71.4387
Year	1960	2014
Admin_Unit	FATA	FATA
Status	Operational	Operational
Type	Concrete Gravity	Small rock filled
Dam_Hgt_m	75	25
Dam_Leng_m	198	82
River	Kabul	
Main_Use	Hydroelectricity	Irrigation

Fig. 17: Warsak Dam and Zao Dam



Name	Dargai Pal Dam	Sheen Kach Dam
Near_City	South Waziristan Agency	South Waziristan Agency
Lat_DD	32.1768	32.4768
Long_DD	69.7185	70.3282
Year	2010	2014
Admin_Unit	FATA	FATA
Status	operational	operational
Type		
Dam_Hgt_m	25	21
Dam_Leng_m	232	200
River		supero walo algad
Main_Use		

Fig. 18: Dargai Pal Dam and Sheen Kach Dam

development is to define its probable location and scale and thus the objective of this study was to use GIS to assess the potential dams for development of freshwater aquaculture in the KPK and FATA, Pakistan. Our paper will provide new information's about KPK and FATA dams and their worth for fisheries.

From the obtained results, GIS mapping revealed that the most of the KPK dams are found in Karak district, as this district contain seven dams.Whereas, District Haripur has six dam and among them,Tarbelais one of the largest dam of Pakistan as shown in Figures 2-18, respectively. According to the recent investigation, study of some physiochemical properties of water, soil and sediments of Tanda and Gandiali dams of Kohat District revealed that the environmental conditions of these dams were in suitable range required for fish growth, survival and stocking and in addition, also save to be used for irrigation and domestic purpose as reported by Zubia *et al.* [15]. Furthermore, previous studies of some workers including Butt [4], Nisar [5], Shahjehan and Khan [6], Ishaq *et al.* [7], Akhthar *et al.* [9] and Haseeb *et al.* [10] proved that freshwater reservoirs of KPK and FATA areas of rich resources for fish fauna. In addition, among all reported fish species, most species were belonging to the family Cyprinidae that are most commonly used as food fishes in human diet, respectively. Hence, our study will provide new information's about KPK and FATA dams and their worth for fisheries and fish culture in these areas. The district wise spatial distribution maps of KPK and FATA dams are as follows:

CONCLUSION

From the obtained results of thepresent study, it had been concluded that through GIS with maps of any preferred dam, fish culturists can see the penalty of their need to locate a new production unit at any particular district to improve the conditions of dams for fish growth and survival in terms of water depth, quality, hydrodynamics, existing dam locations and benthic fauna to support the preparation of aquaculture strategies and development plans, in future which will contribute in the economy of the nation. Such information could also be valuable for determining the growth rate and productivity of fishes that later could be valuable in the systematic, fisheries management and conservation to further improve the ecological setup necessary for growing fish.

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