FEASIBILITY STUDY FOR DEVELOPMENT OF MAP PROJECTIONS FOR PUNJAB PROVINCE

Punjab Urban Land Systems Enhancement (PULSE)

Project, Board of Revenue Punjab

August 2024

CONTENTS

Abbreviations

BoR	Board of Revenue
DGPS	Differential Global Positioning System
GCP	Ground Control Point
GNSS	Global Navigation Satellite System
HSE	Health Safety Environment
PDF	Portable Document Format
PDO	Project Development Objective
PIU	Project Implementation Unit
PLRA	Punjab Land Records Authority
PMU	Project Management Unit
QA/QC	Quality Assurance/Quality Control
PULSE	Punjab Urban Land Systems Enhancement Project
FBR	Federal Board of Revenue
GST	Goods and Services Tax
SoP	Survey of Pakistan
UTM	Universal Transverse Mercator

1. INTRODUCTION

1.1 Background of the Project

The Government of Punjab (GoPunjab) is implementing a project titled the Punjab Urban Land Systems Enhancement Project (PULSE). The Project Development Objective (PDO) of PULSE is to support the GoPunjab with: (i) improved land records; and (ii) identification of land for development, including land for housing programs. PULSE aims to achieve: (i) the provision of digital land records linked to cadastral maps and DRM data; (ii) improved tenure security and access to land for housing; (iii) a unified modern land information system; and (iv) a strengthened capacity and regulatory framework. In this context, the public in Punjab, particularly women and vulnerable groups, will benefit significantly from increased security of land rights and property ownership. The Project comprises the following parts:

a. Component 1: Digital Land Records and Cadastral Maps for the Land Records Management and Information System or LRMIS to develop a seamless and multipurpose cadastral map linked to the digital land records for Punjab Province;
b. Component 2: Land for Housing to support the GoPunjab in the identification, evaluation, and mobilization of low disaster risk public/state lands, including resilient housing;
c. Component 3: Integrated Land and Geospatial Information Systems and Services to establish a modern Land Information System, unifying and integrating rural and urban land records; and
d. Component 4: Project Management and Institutional Strengthening to support the GoPunjab to manage, implement, and supervise project activities, and training and skill development.

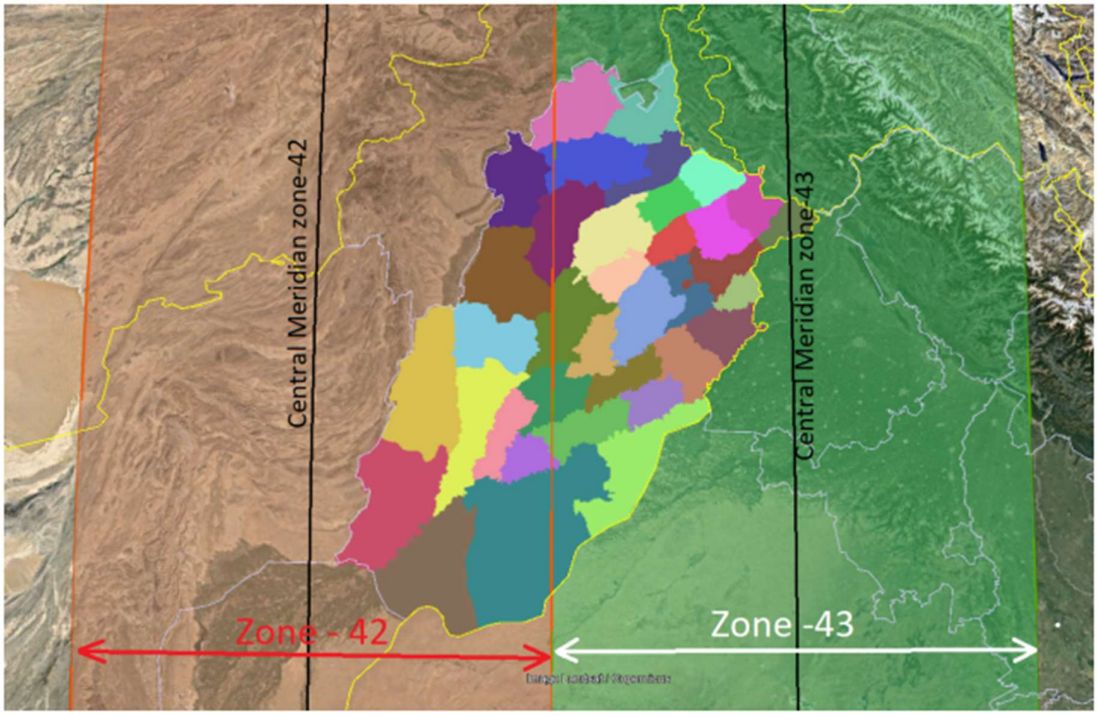
For the implementation of PULSE and pursuant to the agreed terms under the financing, a Project Management Unit (PMU) was established in the Board of Revenue (BoR), together with the Project Implementation Unit (PIU) in the Punjab Land Records Authority (PLRA), to coordinate, manage, implement, and supervise PULSE.

1.2 Status of the Existing Projection System for Punjab

A projection system is a crucial component of cadastral mapping, as it defines how the three-dimensional surface of the Earth is represented on a two-dimensional map. Different projection systems are optimized for preserving specific properties like shape, area, distance, or direction. Depending on the purpose of the cadastral map, one property may be more critical than others. All projections involve some level of distortion, whether it's in shape, area, distance, or direction. The choice of projection can minimize distortion in areas that are important for cadastral mapping, such as property boundaries. The choice of projection can affect the accuracy of measurements taken from

the map. For cadastral purposes, accurate measurements of land parcels are essential. Different Geographic Information System (GIS) software may have varying levels of support for different projection systems. Choosing a projection system that is compatible with the software being used is important for seamless data integration and analysis. If the cadastral map is intended to be used in conjunction with maps or data from other sources, it's important to choose a projection system that facilitates easy integration and alignment with those datasets. Different projections are suitable for different scales of mapping. For cadastral mapping, where detailed and accurate representation of property boundaries is crucial, choosing an appropriate projection for the scale of the map is essential. For PULSE project we are using Universal Transverse Mercator (UTM) Zones 42 and 43. Central meridians of Zone 42 and 43 are at 69 degree and 75 degree respectively. There are some drawbacks to these zones for Punjab Province. For example, the central meridians of both zones do not pass through any District of Punjab except District Narowal (figure 1). Also, the separating line (edges) of zones 42 and 43 is almost passing through the centre of Punjab Province. The Edges of each UTM zones are the regions of higher distortions in terms of distances and areas. There are 9 districts (Attock, Chakwal, Khushab, Jhang, Toba Tek Singh, Khanewal, Vehari, Lodhran, and Bahawalpur) which lie in UTM zones 42 and 43. It means these may experience more distortions than other districts of Punjab.

Figure 1. UTM Zones 42 and 43 for Punjab Province



In the light of obove mentioned issues with current UTM projection, there is immense need for developing new local projections for Punjab Province for the successful implementation of PULSE Project.

2. OBJECTIVES

The objective of this consulting service is to conduct a feasibility study and develop an appropriate projection systems suitable for the most precise and accurate measurements for cadastral mapping using the WGS84 ellipsoid as the geodetic datum. The consulting firm needs to address the limitations and challenges associated with the current UTM Zones 42 & 43 projection system for the Punjab Urban Land Systems Enhancement Project. A qualified and experienced consulting firm will implement this assignment under the supervision of BoR and PLRA with the following activities:

- Carry out a gap analysis of the existing projection systems to identify and analyze distortions occurring in different areas under these projection systems.
- Quantify these distortions as functions of easting and northing coordinates.
- Investigate the implications of district boundaries crossing multiple UTM zones.
- Conduct comparative case studies to explore alternative projection systems used in similar geographic contexts.
- Propose a new projection system tailored to the local scenario, considering the advantages and disadvantages of each option.
- Validate the effectiveness of the proposed projection system through fieldwork and measurement comparisons.
- Suggest and report on implementation of new project system keeping in view the project data.

3. SCOPE OF SERVICES

To achieve the study objective, the consulting firm shall perform all the necessary data collection, fieldwork, processing, analysis, and draft technical reports. The target area will cover the entire territory of Punjab Province. The scope of services for this study encompasses various activities aimed at achieving the study objectives. These include:

3.1 Initial Assessment

- Analyze the coordinate projection system (UTM Zone-42 and Zone-43) used for different cadastral mapping components of PULSE.
- Identification and quantification of distortions in both zones of UTM.

- The detailed examination of the district and Division boundaries impacts.

3.2 Case Studies through Desk Review

- Comparative analysis of projection systems used in neighboring countries or regions with similar geography.
- Exploration of how other regions address challenges posed by multiple UTM zones.

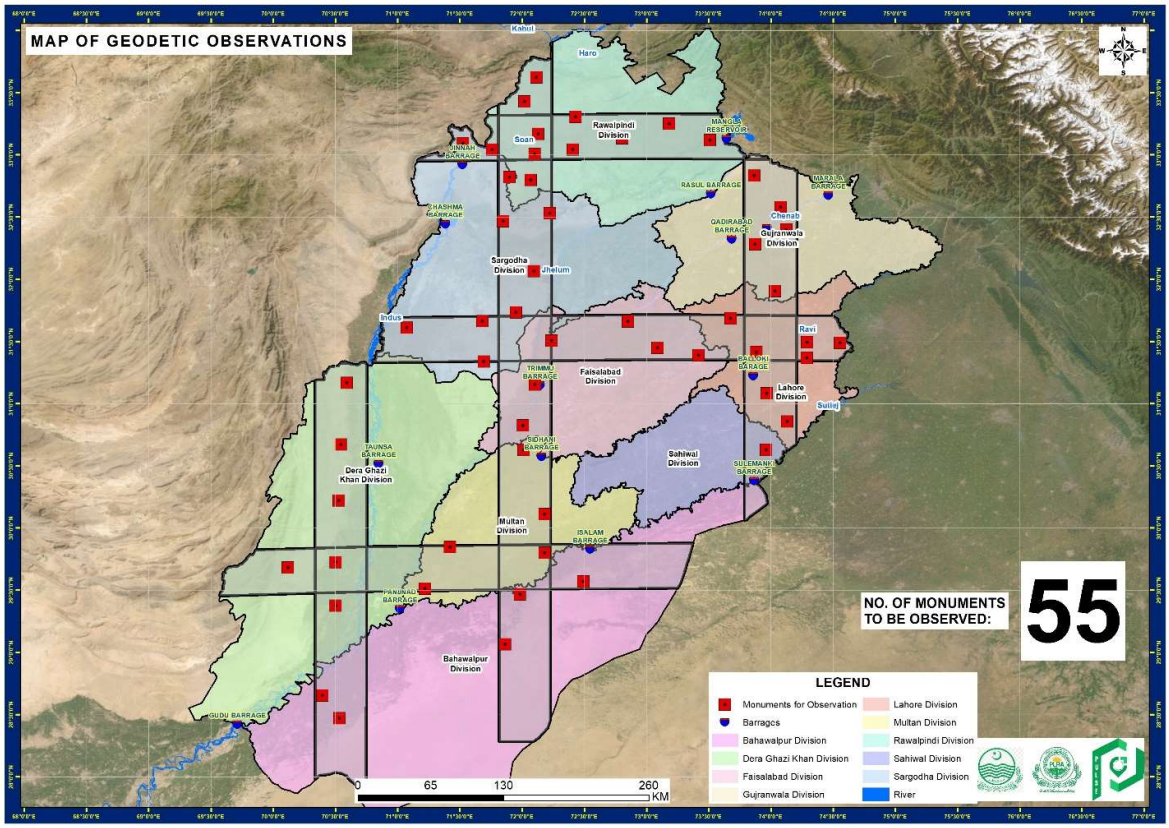
3.3 Proposed Projection

- Research and evaluation for the alternative projection system options.
- Thoroughly analyse the projection parameters and present its findings to the client, including pros and cons of each option.
- Collaboration with the client to finalize the selection of the most suitable projection system for the project.

3.4 Validation of the Finalized Projection System

- Select a set of well-distributed control points across the study area shown on the following map:

Figure 2. Control Points to be Observed for the Punjab Province



- The PULSE will provide the list of selected geodetic monuments. These control points, with known coordinates in both the existing and new projection systems, will serve as the foundation for validation.
- GPS survey coordinates of selected monuments shall be measured by Differential Global Positioning System (DGPS) at Static Mode with continuous reading for 6 to 24 hours depending on baseline length. Quick static measurement is acceptable for baselines less than 10 km. In such a case, 1 hour reading is a minimum plus 5 minutes per every 1 km. In addition, the consulting firm may use a global real-time correction service that provides cm-level horizontal accuracy. In such a case, all rover marks occupy twice, with at least 30 minutes between occupations.
- calculate distances between control points in both systems and compare them statistically. Also, use grid-to-ground conversion using scale. In this method, distances between control points are measured in the new projection system (grid distances) and then converted to ground distances using a scale factor that accounts for projection distortions. These ground distances are compared with actual ground measurements obtained through precise methods like GPS. This comparison helps to identify any systematic errors and ensures that the projection system accurately represents real-world distances.
- Finalized the projection system to ensure it meets cadastral mapping requirements.

3.5 Implementation Plan and Documentation

- Study the current practices of data conversion and migration in project components and provide the detailed implementation plan.
- Conduct a workshop on the proposed coordinate projection system with the project stakeholders.
- Document all findings and the new coordinate projection system.

4. REPORTING AND DOCUMENTATION

4.1 Inception Report

The consulting firm shall prepare a project execution plan and approach to the scope of work. Project execution plan shall be part of the technical proposal and cover the following aspects:

a. Project schedule & methodology
b. Any site preparation/clearance requirements
c. Quality assurance/quality control requirements

d. Survey coordination procedures & Survey permissions/access requirements

e. List of personnel for field works and desk work including the contact person for the field works

4.2 Health & Safety

Prior to the commencement of fieldwork, the consulting firm shall develop an Health Safety Environment (HSE) plan. The HSE plan shall provide the procedures of action for the prevention of accidents, illness and injuries.

4.3 Permissions and Permits

The consulting firm is responsible for gaining all permits and/or permissions required, from the relevant authorities to access and survey the project area. In case of difficulties during gaining the permissions and permits, the consulting firm shall inform the client.

4.4 Photo Documentation

For each survey site, comprehensive photo documentation shall be provided consisting of overview pictures. Photos shall be taken from meaningful positions and whenever possible without zooming.

Photos shall be provided in JPEG format. As a minimum the following parameters shall be provided in EXIF format:

a. Date and time of image capture

b. GPS coordinates of geotagged picture

4.5 Reporting

The consulting firm shall provide weekly basis the progress report to the client during the complete contract duration. The progress report shall present the status and progress of the works.

After the completion of the survey works the consultant shall submit a final report comprising the documentation of the desk works, survey works, processing methods, accuracy statement, etc.

The reports shall be handed as an editable Microsoft Word document as well as in PDF format.

The report shall include the following items:

a. Introduction

b. General description of the scope of work

c. Detailed description of the executed works

d. Details of proposed projection system, including parameters of *.prj

e. DGPS coordinates (Earth Center Earth Fixed & Projected)

f. Raw data of DGPS coordinates

g. QA/QC methods and results

h. Location sketches - Photographs of locations and Google Earth Imagery.

5. DELIVERABLES & TIMELINES

SR. No.	MILESTONES	TIMELINE (WEEKS)
1	Inception Report	01 Weeks
2	Initial Assessment Report, Case Studies	04 Weeks
3	Proposed Projection & Validation of the Finalized Projection System	04 Weeks
4	Implementation Plan and Documentation	03 Weeks
TOTAL		**12 Weeks**

6. PAYMENT SCHEDULE

The Payment will be released against submission and acceptance of each deliverable under Scope of Services as follows:

Sr. No.	MILESTONES	PAYMENT (%AGE)
1	Inception Report	10%
2	Initial Assessment Report, Case Studies	30%
3	Proposed Projection & Validation of the Finalized Projection System	30%
4	Implementation Plan and Documentation	30%
TOTAL		**100%**

7. ELIGIBILITY CRITERIA

The eligible bidding firm should demonstrate the following minimum criteria;

a. Valid/active NTN and GST Number with Income Tax return from 2022 to 2023.

b. In case, collection of any spatial data from field to carry out this assignment, the firm will hire services of SOP registered firm/company.

c. Verifiable experience (study or Implementation of coordinate projection systems in different geospatial measurement projects or similar geodesy-related projects) in Pakistan or other countries.

d. At least five (05) years of verifiable experience in geospatial and geodesy domains.

Sr. No.	KEY POSITIONS	ACADEMIC QUALIFICATION	EXPERIENCE
1	Team Lead	M.Phil / Ph.D. Geodesy	10 / 5 Years
2	Geospatial Data Modeling Specialist	M.Phil / Ph.D. Computer Science	10 / 5 Years
3	Geodetic/Survey Engineer	B.Sc. (Civil Engg.) or 16 years of education in GIS/Geomatics	10 Years
4	Spatial Data Analyst	16 years of education in GIS/Geomatics/Space Sciences	5 Years
5	GNSS Expert	16 years of education in GIS/Geomatics/Space Sciences	5 Years
6	Survey Engineer	B.Sc. (Civil Engg.) or 16 years of education in GIS/Geomatics/Space Sciences	5 Years