Crop Estimation and Geographic Mapping System (CEGMaS)

No.	*Elapsed time from start (in months) of the project*	*Milestone*	*Deliverables*	*Status*
1.	1.7 Months	**(Phase-1)** M1.1: Delegate responsibilies and tasks	**(Phase-1)**	**Submitted**
	During the first quarter of project CEGMaS the main focus remained on team building/hiring, advertisement of Ph.D. scholarships so that suitable candidates could be selected through the University selection process and setting up of project website during the initial 20 days after commencement of project. The anticipated date of completion of hiring process as per project schedule was 21st of April, 2013 which was delayed to 14th May, 2013 due to the ban imposed by the Election Commission of Pakistan for the general elections. After the ECP ban was lifted, applicants for the posts of RA/Developers were interviewed by the University Selection Committee on the 14th of May, 2013 and vacancies for Digital Image Processing Expert, Geo Mapping Expert and Web-designer were filled. The committee could not find suitable candidates for other two positions of RAs and were therefore re-advertised. For the Ph.D. scholarships, advertisement appeared in the national newspapers on the 25th of February, 2013 – ten days before the official commencement date of the project so as to enable applicants enroll during the Spring, 2013 session which started from 11th of March, 2013. Two Ph.D. students were selected after completion of admission requirements for Ph.D. set forth by UET Peshawar. The first Ph.D. student enrolled in taught courses in Fall, 2013 and the second Ph.D. student enrolled in Spring, 2014. Likewise, the project website had been launched within the first 20 days of the project commencement and can be accessed at www.cegmas.com			
2.	3.2 Months Total elapsed time after achievement of the last Milestone of Phase-1=6 Months	M1.7. Finalize implementation plans, acquisition of hardware and software, strategies and development tools for development of CEGMaS project	D1.4: Summary of systems, tools and implementation guidelines for implementation of server side GIS application, front end design, the database architecture and acquisition of the required hardware	Submitted

	3.2 Months 3.7 Months 4.5 Months 5.2 Months 6 Month	**(Phase-1)** M1.2: Completion of Design Specification M1.3: Finalized operational procedures of CEGMaS M1.4: Completion of Development guidelines for the CEGMaS development phase M1.5: Agreed and finalized procedures and essential knowledge for acquisition and development of spectral signatures and spectral library M1.6: Completion of CEGMaS GIS framework specification	**(Phase-1)** D1.1: Specification of systems and methods customized for tobacco crop esitmation in Pakistan D1.2: Summary of systems, tools and implementation guidelines for implementation of crop estimation using multi-spectral/hyper-spectral satellite imagery based on the spectral signature of various species of tobacco plant D1.3: Summary of systems, tools and implementation guidelines for implementation of a crops estimation system using GPS assisted ground surveys through cellular networks/logging information	**Submitted**
	During the second quarter of the project the team worked on the overall specifications of systems and methods that are required for tobacco crop estimation in Pakistan. This involved research on the prevalent software tools used around the world in various research groups for similar operations, short listing of classification algorithms for classification of multi-spectral imagery using the various types of supervised and unsupervised classification algorithms, likewise, the output format for the classified data was agreed as per the system design, followed by design specification of the front end of the CEGMaS GIS. All the design specification of the front end and the information flow helped in designing the database that would later store the processed data. Similarly, design specification for the CEGMaS mobile app was finalized during this quarter.			

	It is important to mention that during the second quarter the team was already in the end of tobacco crop season. For this purpose, they processed a request for imagery acquisition through SUPARCO who provided the pilot region SPOT-5 satellite imagery acquired towards the end of June, 2013. The same imagery was later on in use by the image processing team during third and fourth quarter. Second quarter mainly focused on system design – the design that was used for development during the following quarters.			
3.	6.9 Months	M2.7: Completion of development of mobile application framework and connectivity modules	D2.7: Mobile surveying software and connectivity components	Submitted
	7.7 Month	(**Phase-2**) M2.1: Completion of tobacco plant's spectral signature acquisition	(**Phase-2**) D2.1: Tobacco Plant's spectral signature and classification data	Submitted
	7.8 Months	M2.8: Completion of CEGMaS GIS's database development and validation	D2.8: Database for the GIS of the project CEGMaS	Submitted
	8.7 Months	M2.9: Validation and completion of GIS front end, geo-mapping modules, information overlays	D2.9: Web interface of the CEGMaS GIS	Submitted
	9.7 Months	M2.3: Validation and completion of image adjustment techniques for the spectra acquired during T2.1	D2.3: Adjustment algorithms	Submitted
	The development activities in this phase focused on three areas: (1) the Regions of Interests (RoIs) acquired during June, 2013 in the pilot regions were used in the ENVI software tool and various classification algorithms were tested on the 2.5 m, multi-spectral, SPOT-5 imagery. Project CEGMaS relies on the outcome of image processing team – accuracy and credibility of the classification results would make CEGMaS as more viable solution to the problem it is addressing – therefore, the image processing techniques put in practice in this quarter continued during the whole of phase-2 of the project i.e. up to the 6th quarter. (2) Part of the team worked on completion of the development of mobile application for ground-truth data collection as designed and specified during second quarter. Connectivity modules, database connections, front end design and flow of the mobile App went through a number of changes at various development steps. The CEGMaS mobile app is developed for Android phones. (3) Likewise, during this quarter the GIS front end development started. The database was also developed keeping in view the information required from the KML files generated by the image processing team and that required by a normal user at the GIS front end. The database design went through a series of changes as a result of design improvements at the GIS front end and also inclusion/exclusion of fields from the output generated by the Image processing team.			

4.	10 Months	M2.2: Completion of design and development of spectral database	D2.2: Spectral database with provision for extension and inclusion of data related to other crop types and their respective species	Submitted
	11.5 Months	M2.4: Formulated digital image processing techniques for spectral analysis	D2.4: Spectral Analysis tools and algorithms	Submitted
	11.5 Months	M2.10: Implemented information security schemes and its validation	D2.10: Information Secuirty mechanisms	Submitted
	Fourth quarter involved rigorous testing of the various classification methods available for crop identification. The analysis ranged from Unsupervised to Supervised classification categories and several classifiers including maximum likelihood, Minimum distance, Mahalanobis distance and parallelpiped. Different thresholds were used during the analysis. The outputs were mapped using KML files on Google Maps and several issues were identified. As a result of new learning experiences from imagery analysis during this quarter the Mobile App design, the web-based GIS and its corresponding database had to go through several sets of changes – for instance it was noticed that once a KML file was parsed into the database including tobacco fields of the whole pilot region (which is 60 by 60 square kilometres area) it used to take a long time during mapping on the web-based GIS that uses Google Maps – every time a user would zoom in or zoom out the system would had to go through a refresh sequence and that waiting time had to be experienced again. The team addressed this issue by dividing the whole pilot region into area subsets on district basis. For example district Mardan which is the main districts in the Pilot region along with Malakand and Swabi – district Mardan was divided in to 05 sub areas using an XML file of regional coordinates marking boundaries of each sub-area. So now, when one joint KML file is fed into the GIS by the image processing team, the system parses the KML file field by field and fills in the database based on the sub-areas marked by the XML. This not only helps in the normal GIS functionality it also makes the region wise analysis easier and comprehensive.			
5.	13.7 Months	M2.5: Developed and validated image segmentation techniques	D2.5: Segmentation and decision making algorithms	Submitted
	A number of classification techniques applied during the fourth quarter gave variable figures in terms of the estimated area. As the project in the phase-3 and phase-4 will involve checking and assessing the accuracy of classification, therefore, the GIS has to have the ability to carry out web-based and ground-truth data based accuracy analysis. Likewise the online and ground-truth accuracy assessments would be backed up by the built-in accuracy assessment tools in the Excellis ENVI toolbox. Therefore, during this quarter the GIS ability to help representative of tobacco companies conduct 'random check' online at specific areas in the pilot region was enabled. Using this ability a tobacco company field supervisor can randomly pick the area he is supervising where they have local knowledge of almost all of the tobacco fields – he would be able to browse through the tobacco fields and either mark them as 'accurately classified', 'over-estimated' or			

	'underestimated'. Likewise, the second option enabled during this quarter in the GIS maps the ground-truth data collected through the CEGMaS mobile app and overlay that on Google Maps where the already classified fields are also overlaid. This option gives a visual comparison and identifies any classification mismatch. Based on the above mentioned development activities during the fifth quarter – the statistics and reporting module was revised. The GIS now shows statistics specific to the sub-area selected by a user, the field wise detail of tobacco fields, displays imagery meta data, gives area information, displays the number of accurately classified fields, displays the number of overestimated fields and also the under-estimated fields and provides the overall accuracy of classification to the user. All the development tasks during 4th and 5th quarter are to be integrated during the 6th quarter.			
6.	15.5 Months	M2.6: Completion of development and validatiion of artificial intelligence schemes for classification of techniques based on the spectral information	D2.6: Artificial intelligence based information classification methods from spectral data	Submitted
7.	15.5 Months **Total elapsed time after achievement of the last Milestone of Phase-2=15.5 Months**	M2.11: Completion of reporting and statistics generation modules	D2.11: Reporting and statistical analysis tools and components of the GIS	Submitted
8.	16.4 Months 17 Months 17.7 Months	(**Phase-3**) M3.1: Accomplishment of System integration M3.2: Completion of Validation of integrated system M3.3: Completion of Accuracy check	(**Phase-3**) D3.1: Integrated and validated system	Submitted

9.	16.4 Months	M3.4: Recruitment of surveyors	D3.2: Employed surveyors	Submitted
10.	18.7 Months 19.7 Months	(**Phase-4**) M4.1: Completion of Surveyor training and task force formulation M4.2: Completion of stakeholder's requirement of the survey and pseudo field trials	(**Phase-4**) D4.1: Trained task force capable of operating the mobile equipment, application and conducting the surveys according to the project requirements	
11.	20.5 Months	M4.3: Complete survey of the Shergarh region	D4.2: Field mapping of Shergarh region. Mapped fields and geographic coordinates will be shared with the ICT RDF.	Submitted
12.	21.5 Months	M4.4: Complete survey of the Sawabi region	D4.3: Field mapping of Sawabi region. Mapped fields and geographic coordinates will be shared with the ICT RDF.	Submitted
13.	22 Months 22.7 Months	(**Phase-5**) M5.1: Complete random checks / Re-survey of randomly selected 10 percent fields M5.2: Completion of cross checking of accuracy comparison of data acquisition in phase-4 with the 10 percent data	(**Phase-5**) D5.1: Optimized and re-caliberated system according to the end-	Submitted

	23.5 Months 24.2 Months 24.7 Months 26 Months	M5.3: Completion of comparison of remote sensing decisions with those of the ground-truth data M5.4: Identified technical factors that cause inaccuracies M5.5: Understanding of the end-users' perspective on the developed system M5.6: Implementation of suggested changes	user requirements and technical re-evaluation D.5.2: Demonstration of optimized and recaliberated system to representatives of ICT RDF	
14.	26.5 Months	(**Phase-6**) M6.1: Completion of Deployment and transition agreement	(**Phase-6**) D6.1: Mutually agreable terms and conditions document between the CEGMaS team and the PTB in presence of the ICT RDF's representatives and in coherence with the policies of the ICT RDF	Submitted
15.	28.2 Months	M6.2: Deployment of CEGMaS	D6.2: Deployed product at the PTB. Representatives of the ICT RDF will be invited during the deployment phase.	Submitted

16.	28.5 Months	M6.3: Post-deployment validation success	D6.3: Validated deployment	Submitted
17.	31.5 Months	(**Phase-7**) M7.1: Completion of CEGMaS documentation	(**Phase-7**) D7.1: User manuals, update website and book highlighting the development cycle and technical challenges of the CEGMaS project	Submitted
18.	32 Months	M7.2: Project Information Dissemination	D7.2. Workshop highlighting the significance of CEGMaS, its impact, overview of various development activities, immediate facts and figure found through the pilot surveys, expected VS achieved benefits to the stakeholders, future extensions of the CEGMaS	Submitted
19.	32.5 Months	M7.3: Completion of end-user training	D7.3: Trained end-users	Submitted and found to be satisfactory.