Project for the Strengthening of Spatial Data Infrastructure in Member States and Territories of the Association of Caribbean States

Geodesy Course Report

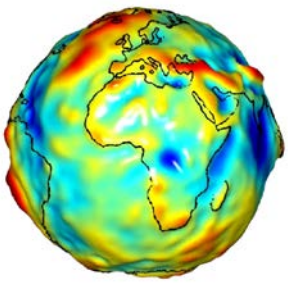
One of the important phases of the project is to improve the capabilities of the human capital to produce, integrate and use geospatial information in decision-making. The design of courses and workshops, besides the exchange of information on best practices, is the method that will be applied in order to achieve it. For that reason, from December 8th to 12th 2014 the first "Geodesy" training course was carried out at INEGI headquarters.

Geodesy is a basic science to other disciplines such as surveying, mapping, photogrammetry, civil engineering and geographic information system, which needs to implement geo-referenced information. For this and other attributes the National Geographic Institute of Spain (IGN) refers to it as the "Infrastructure of the Infrastructures". It is essential, therefore, to have solid knowledge about this issue since it will be the basis for strengthening the Spatial Data Infrastructure (SDI). It is likely that this was one of the reasons that prompted countries to seek with the highest priority, training in the field.

It is important to mention that the strengthening for the Geodetic Network of the Caribbean region is a priority within the project activities, through the incorporation of fixed stations in the region, and the acquisition of geodetic equipment and training to establish control points; that will involve implementing a Geodesy workshop, in which knowledge about the use and management of geodetic equipment will be updated.

First Course of the Caribbean Project

GEODESY



Instructor: Dr. Keith Miller (Trinidad and Tobago)

Location: INEGI's Training Building, located in Héroes de Nacozari Sur 2301, Fracc. Jardines del Parque c.p. 20276, Aguascalientes.

Course objectives

1. Learn the different datum used in Geodesy and apply the mathematical models used in the calculations.
2. Learn the geodetic elements and reference systems to determine the point position on the earth's surface.

Syllabus

December 8th 2014

TIME (HRS.)	
8:30 – 9:00	Welcome reception
9:00 – 9:30	Opening words
9:30 – 9:45	Diagnostic Evaluation
9:45 – 10:00	Coffee break
10:00 – 10:15	Photo
10:15 – 11:30	Lecture 1-Introduction to geodesy
11:30 – 13:00	Lecture 2- Celestial methods
13:00 – 13:30	Lunch
13:30 – 15:00	Practical 1- Azimuth determination
15:00 – 15:10	Coffee Break
15:10 – 16:30	Lecture 3- Gravity

December 9th 2014

TIME (HRS.)	
8:30 – 10:30	Practical 2- Gravity models and gravity data
10.30 – 10:40	Coffee break
10:40 – 12:40	Lecture 4- Datums
12:40 – 13:10	Lunch
13:10 – 14:10	Lecture 5- Ellipsoidal surfaces
14:10 – 15:10	Practical 3- Ellipsoidal calculations and projections
15:10 – 15:20	Coffee break
15:20 – 16:30	Practical 3- Continuation

December 10th 2014

TIME (HRS.)	
8:30 – 10:00	Lecture 6- Terrestrial Reference Frames

10:00 – 10:10	Coffee break
10:10 – 12:00	Practical 4- ITRF
12:00 – 12:30	Lunch
12:30 – 13:30	Guided visit to the INEGI
13:30 – 15:00	Lecture 7- CORS stations and VRS
15:00 – 15:10	Coffee break
15:10 – 16:30	Practical 5- CORS data

December 11th 2014

TIME (HRS.)	
8:30 – 11:00	Lecture 8- Local datums
11:00 – 11:10	Coffee break
11:10 – 12:10	Practical 6- Modern national datums
12:10 – 12:40	Lunch
12:40 – 14:40	Lecture 9- Heights
14:40 – 14:50	Coffee break
14:50 – 16:30	Practical 7- Heighting

December 12th 2014

TIME (HRS.)	
8:30 – 10:00	Lecture 10- Methods for Datum Transformation
10:00 – 10:10	Coffee break
10:10 – 12:10	Practical 8- Software parameters and datum transformation
12:10 – 12:40	Lunch
12:40 – 14:10	Lecture 11- Determining Transformation Parameters
14:10 – 15:40	Practical 9- Transformations and datums
15:40 – 15:50	Coffee break
15:50 – 16:30	Summary

Course materials:

Each participant was given a folder with the event agenda, block for notes, a set of copies of the practicals, a spril-bind of the readings, CD, USB, and a city map of Aguascalientes.

Infrastructure:

Computer Lab of INEGI's Training building, a computer per person and geodetic software provided by the instructor. It featured ArcGis software with 3D module Analysis and Microsoft Office Suite.

Course participants:

Country	Institution	Participant	Email.	Office telephone
Antigua and Barbuda	National Office of Disaster Services	Alvah Osworth Guisard	alvahguishard@gmail.com	24206268462
Bahamas	Bahamas National GIS Centre	Duane Miller	duanmiller@bahamas.gov.bs	2423268564
Barbados	Lands and Surveys Department	Leandre Murrell-Forde	Leandre.Murrell-Forde@barbados.gov.bb	2463102004 2463102000
Cuba	Oficina Nacional de Hidrografia y Geodesia(ONHG)	Robin Alonso Téllez	hg@unicom.co.cu	5372122307
Cuba	Oficina Nacional de Hidrografia y Geodesia (ONHG)	Maura María Águila Fuentes	hg@unicom.co.cu	5372122305
Dominica	Lands and Surveys Division	Ali Cuffy	bevarige@yahoo.co.uk	17672663944
República Dominicana	Instituto Cartográfico	Ramón Antonio Guerrero Severino	guerreroseverino@hotmail.com	8095083311
Grenada	National Water and Severage Authority	Anthony Roberts	dosign@yahoo.co.uk	14754402155
Haïti	Centre National Information Geospatial (CNIGS)	Jean Beker Neptune	neptunejeanbeker@yahoo.fr	22449980 22449981
Jamaica	National Land Agency	Richard Mais	richard.mais@nla.gov.jm	18767505263
Martinique	Conseil Regional de Martinique	Frederic Jean Louis	frederic.jean-louis@region-martinique.mq	596596596477 596696211138
Martinique	Conseil Regional de Martinique	Jocelyne Pintville	jocelyne.pinville@region-martinique.mq	596596382
St. Lucia	Survey and Mapping Unit	Vincent Jean Baptiste	vjnbaptiste@gosl.gov.lc	17584684466
St. Vincent and the Grenadines	Lands and Surveys	Alrick Williams	pssfrancis@gmail.com	178461310
Trinidad and Tobago	Lands and Surveys	Yashpal Singh	irmp@tstt.net.tt	8686248023
Sint Maarten	Kadaster	Robert Boekhold	survey@kadastersxm.org	5422282
Suriname	Management Institute GLIS	Jo-Ann Graanoogst	jo-anngraanoogst@miglis.sr jr_graan_oogst@hotmail.com	403783/85
ACS	ACS	George Nicholson	gnicholson@acs-aec.org	
Trinidad and Tobago (UWI-instructor)	Geomatics Engineering and Land Management	Keith Miller	keith.miller@sta.uwi.edu	
Trinidad and Tobago (UWI)	Assistant instructor	Madiha ata Ahmed Farag	keith.miller@sta.uwi.edu	

Country	Institution	Participant	Email.	Office telephone
México	INEGI	Carlos Maldonado Jarquín	carlos.maldonado@inegi.org.mx	9515124827 ext.2606
México	INEGI	Víctor Hugo Sánchez Zárate	hugo.sanchez@inegi.org.mx	4448341845 ext.8536
México	INEGI	Guido González Franco	guido.gonzalez@inegi.org.mx	9105300 ext.1481
México	INEGI	David Ávalos Naranjo	david.avalos@inegi.org.mx	9105300 ext.4000

Results

1- Representatives from 15 countries out of the 18 invited participated (Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Grenada, Haïti, Jamaica, Martinique, República Dominicana, Saint Lucia, Saint Vincent and the Grenadines, Sint Maarten, Trinidad and Tobago, Suriname); representing more than 80% of participation.
2- The course was developed based on the plan, with a total of 40 hours of sessions.
3- Both Cuba and Martinique brought 2 participants each, so there were in total 21 participants including 4 from Mexico (2 from INEGI Aguascalientes, 1 from INEGI Oaxaca and 1 from INEGI San Luis Potosí).

After completing the course, participants answered a test in order to evaluate the event and the instructor's performance. The following tables are the evaluation results.

Table 1

FINAL EVALUATION OF THE COURSE	SYMBOLOGY				
	EXCELLENT	VERY GOOD	GOOD	REGULAR	UNSATISFACTORY
Reagent Evaluation	**TOTAL**				
The course contents are applicable to the activities I perform.	41%		35%	18%	6%
I was clearly informed on the usefulness and purpose of the course.	41%		35%	18%	6%
It was confirmed with adequate advance my participation.	18%	41%		35%	6%

The course content provided me the tools to solve different problems or needs of my workplace.	29%	41%	18%	6%	6%
The difficulty of the course content was progressive during the development of the course.	29%	59%		6%	6%
During the course, I was told how to get the manual electronically.	47%	35%	18%		
My expectations of the course were fully covered.	41%	35%	24%		
The thematic structure of the course provided an adequate continuity.	47%	24%	24%		6%
The equipment used for teaching (projector and computer) worked perfectly.	53%	29%	6%	6%	6%
Overall, the type of training provided is the one I like receiving.	24%	65%		6%	6%
The packaging, order, cleanliness of the room and the furniture was adequate.	47%	47%			6%
The contents of teaching used during the course were appropriately related to the topics discussed by the instructor during the course.	59%	35%			6%
The material used during the course was legible.	47%	41%	12%		
I had easy access to the manual and presentations used in the course.	47%	41%	12%		
The course contents are updated, innovative and aligned to institutional development.	59%	41%			

Note: The results do not consider two questionnaires from the participants of Martinique who requested to send the assessment later on, without favorable results.

Percentage of the white color in the table, represent no reply

Table 2

FINAL EVALUATION OF THE COURSE	SYMBOLOGY				
	EXCELENT	VERY GOOD	GOOD	REGULAR	UNSATISFACTORY
Reagent Instructor Evaluation	**TOTAL**				
The instructor encouraged the participation of members of the group.	35%	59%			6%
The times used by the instructor were adequate.	35%	29%	35%		
The instructor clearly stated course content.	59%		35%		6%
The instructor kept the group's interest for the subject.	29%	53%		12%	6%
The instructor showed an appropriate knowledge of the course content.	53%		35%	6%	6%
The occasions were appropriate when the instructor provided feedback.	24%	41%	24%	6%	6%
The instructor showed impartiality when evaluating the work of the group.	41%		47%	12%	
The instructor showed flexibility to adapt to the group.	41%		53%		6%
The demand shown by the instructor before the group was adequate to achieve the course objectives.	35%	53%		12%	
The instructor respected all members of the group.	82%			18%	

Diplomas:

At the end of the course each participant was given a diploma signed by president of UN-GGIM Americas, Rolando Ocampo Alcántar in the frame of the Proyect for the Strengthening of Spatial Data Infrastructure in Member States and Territories of the Association of Caribbean States.

The expenses of the Geodesy Course were the following:

EXPENSES						
COUNTRY	NAME OF THE PARTICIPANT	FLIGHT TICKETS	LODGING	BOX LUNCH	STAYING	PER DIEM
Antigua and Barbuda	Alvah Osworth Guishard	30,072	6,000	250	2,366	3,000
Bahamas	Duane Miller	14,552	6,000	250		3,000
Barbados	Leandre Murrell-Forde	26,205	6,000	250		3,000
Cuba	Maura María Águila Fuentes	8,307	6,000	250		3,000
Cuba	Robin Alonso Téllez	8,307	6,000	250		3,000
Dominica	Ali Cuffy	26,001	6,000	250	2,366	3,000
Grenada	Anthony Ronald Roberts	23,380	6,000	250		3,000
Guyana	Donald Singh	24,343	6,000	250		3,000
Haiti	Jean Beker Neptune	22,036	6,000	250		3,000
Jamaica	Richard Mais	17,255	6,000	250		3,000
Martinique	Fréderic Jean-Louis	21,149	6,000	250	4,366	2,500
Marinique	Jocelyne Pancaldi	21,149	6,000	250	4,366	2,500
República Dominicana	Ramón Antonio Guerrero Severino	32,430	6,000	250		3,000
St. Maarten	Robert Boekhold	16,756	6,000	250		3,000
St. Lucia	Vincent Jn Baptiste	16,158	6,000	250	4,366	3,000
St. Vincent and the Grenadines	Alrick Williams	22,329	6,000	250	4,732	3,000
Suriname	Jo- Ann-Graanoogst	25,153	6,000	250	2,366	3,000
Trinidad and Tobago	Yashpal Singh	19,759	6,000	250		3,000
INSTRUCTOR	Keith Miller	31,408	9,000	250		3,000
ASSISTANT INSTRUCTOR	Madiha Ata Ahmed Farag Miller	31,408	9,000	250		3,000
México	Deborah Rangel Encontra		6,000	250		
México	Eugenia Rodríguez		6,000	250		
México	José Eduardo de la Torre		6,000	250		
Technical Committee	George Nicholson	17,121	6,000	250		2,500
		455,278	150,000	6,000	24,927	61,500

Total: MXN$ 697,705

Lessons learned:

1. Send formal invitations as a first step to facilitate the visa process.
2. Analyze the candidate's curriculum and ensure that she/he specializes in the field.
3. Make a diagnostic evaluation before the course to measure the level of knowledge of the participant
4. Request an official report of the reasons, in case the assistance is canceled.

Geodesy course report

Keith Miller
Department of Geomatics Enginering and Land Management
The University of the West Indies

Aim

In a wider perspective the Project for the Strengthening of Spatial Data Infrastructures in member States and territories of the Association of Caribbean States is intended to build capacity for acquisition and management of spatial data acquired within the territories. The specific aim of this course was to develop an appreciation for modern geodetic datums that would enable a move towards adoption of modern datums within national spatial data infrastructures.

Content

Objectives must then accommodate transition from traditional reference frames to new and deal with technologies that have lead to a need for change. Infrastructural requirements at state level and use of modern datums must then be addressed together with standards. Content of the programme was then organised as follows through a series of lectures and practical work undertaken using computer software with detailed steps through the process being provided. The course would therefore offer an understanding as well as developing skills in computations and visualisation of geodetic data.

Introduction. A review of geodetic datums from their origins to present day effectively covering the entire course content. This provided an overall context for the remaining material.

Celestial methods. Traditional datums were established using such techniques and celestial methods are still used in some territories to determine orientation for cadastral surveys. This introduced the subjects of reference surfaces and celestial reference frames in a practical sense. The practical component involved computations on a pre-prepared spreadsheet with participants needing to obtain parameters associated with motion of the Sun and other values.

Gravity. While gravity has not been significant in surveying in the past, it is now fundamental to determining a modern vertical reference surface. Lecture material dealt with gravity observations, corrections and their use in constructing models. Practical work required participants to work in ArcMap to visualise gravity data that has been obtained regionally and gravity based Earth models that have been determined internationally.

Datums. Specifically dealt with the definition and realisation of traditional geodetic datums. How astronomic observations are used together with selected parameters to establish the unique datums that exist in the territories and their expansion nationally. A review of the

different datums in the region resulted in a discussion on the age and techniques used in their realisation to offer later comparison with modern methods.

Ellipsoidal surfaces. Detailed the techniques used in computations for position, lines of sight and distances, then moved on to map projections and distortions involved. Practical work undertaken using freely available software and ArcMAP demonstrated results from computations on the spheroid and in the projection of lines onto the grid. This also provided skills in working with ArcMAP to define and select datums and projections.

ITRF. Moving to modern reference frames the international Terrestrial Reference Frame was defined and its use with data acquired with GNSS equipment described. The need to include velocities and how these are dealt with was detailed. Practical work involved use of internet based resources to locate information on the reference frame and details of points within ITRF.

CORS stations and VRS. Realisation and densification of ITRF through CORS networks and accessing data is critical in working within ITRF. In addition to accessing data from existing stations the lecture material also dealt with requirements for establishing new stations and the hierarchical structure for level of control based on CORS networks. Further real time use under VRS was also explained. Practical work involved the use of on-line processing tools to establish control using GNSS and on downloading data and metadata from existing CORS stations.

Local datums. As maps cannot currently accommodate velocities that are included in ITRF there is a need to establish local datums differently. Through examples from Europe, Australia and New Zealand the ways in which modern local datums are defined based on CORS stations and ITRF was identified. The need to densify control through the use of survey marks and means of dissemination of control survey data through the internet was also addressed. Finally, the issue of accuracy was considered particularly in the context of RTK through an example of use of GNSS techniques in cadastral surveying. Practical work considered standards for use of GNSS technologies in different ways in control surveys. This was achieved by participants reviewing documents that exist from specific locations and subsequent discussion.

Heighting. Vertical and horizontal control is treated different and that will not change. However, there are problems with the realisation and maintenance of existing height networks that were considered. Modern vertical reference systems are based on models that are developed from gravity data and this was proposed as a way forward. Practical work saw the participants performing computations to assess corrections necessary to level data under normal-orthometric height systems and using geoidal models to convert GNSS derived heights to this convention.

Datum Transformations. When moving to a new datum it is necessary to bring existing data forward, although in many cases around the Caribbean modern data is all too often taken backwards. A review of methods for transformation was provided including geocentric and grid based approaches. Transformations between ITRF's and the need to include velocity of ITRF in defining a modern reference frame were also considered. Practical work involved participants locating datum details and transformation parameters

from freely available sources and using freely available software to perform transformations.

Transformation parameters. Considered means of determining transformation parameters, different conventions that exist and an assessment of accuracy of resulting parameters. Regional examples were used to discuss the level of inaccuracy that typically exists and

hence elaborate on the need to move to a modern datum. Practical work developed skills in using ArcMAP to undertake datum transformations.

Delivery expected a level of prior understanding in traditional datums together with skills in using software for computations and mapping.

Guest sessions

David and Guido from INEGI each delivered a session that complemented the programme and a tour of some departments within INEGI demonstrated the extent and capacity of a modern national spatial data centre.

Geoidel modelling. David presented a regional programme operated out of INEGI towards development of a regional geoidal model, a requirement for a modern height datum. Emphasis on the need for gravity data and specialist knowledge necessary for modelling reinforced lecture material.

Data processing centre. Guido operates a GNSS CORS data processing centre within INEGI Regular solutions for primary stations are essential in operating a modern geodetic datum and such centres operating internationally provide regional control for local datums. The session that involved both a presentation and hands on access to regional information. Delivery by a specialist in this component added details to techniques and requirements beyond those included in the lectures.

Tour of facilities. Due to time constraints it was only possible to visit two departments within INEGI. Firstly, a department that maintains records and specimens of geology, palaeontology and flora acquired nationally. This emphasised the need to consider data beyond that represented on a topographic map. National spatial data infrastructures need to retain records of all data acquired with spatial attributes. Secondly, the map production facility where plane and 3D hard copy maps are produced. Here, the size of Mexico and advanced techniques used in mapping and associated geodetic reference frames became apparent.

Facilities

The teaching room at INEGI was equipped with modern computers and high speed internet. All resources required for delivery including specialist software and data needed for practical exercises had been installed prior to commencement of delivery. The delivery area contained multimedia projector and white board that could be used jointly. The technology functioned almost without fault, technical support was available throughout and a couple of small difficulties that were encountered were resolved within a few minutes. In

terms of resources the training facilities and support offered by INEGI are excellent and ideally suited to the purpose.

Participants

Background. It became apparent that participants came from a variety of background. All worked within government departments with some interest in spatial data, but with very different specializations, which could broadly fit into three groups. The largest group were land surveyors working in surveying and mapping departments where little mapping is undertaken and their primary role is in cadastral survey work. Within this group the level of operating within the organization varied, while some were senior survey staff others were recent graduates. Another group of the delegates are involved in NSDI work within their home country and this group showed more familiarity with the requirements and status of mapping than the surveyors. The third group are involved in broader issues of land management in some way and this group lacked the expected background in reference frames associated with spatial data.

IT skills. The level of IT skills required for the practical components also varied. All participants had basic keyboard skills and could use email and word processing packages, but beyond that the level varied considerably.

Language. English language skills of some of the participants from the non-English speaking countries was inadequate for an intensive course delivered solely in English. In two cases the final assessment was written in a different language.

Assessment

Method. At the end of the course a short test was administered requiring participants to anonymously complete one line answers to short questions relating to the technical components of the programme. Two of the participant had left before the test was administered, but some of the INEGI staff who had attended the course also completed the test. In all 19 responses were received, but two had been completed in a language other than English, so 17 tests were reviewed.

Grading. In reviewing the tests if a response to a question was appropriate and related to the question then it was considered correct. If a response was provided that was inaccurate, or did not relate to the question then it was considered incorrect. In many cases there was no response, these were not included in the count of answers. The test is provided in Appendix A, there is a mistake in that question 12 is repeated as question 14, some of the participants noticed this, but others did not. A summary of the marks is provided below by question.

Question	Number of responses	Number of correct responses	Responses (%)	Correct responses (%)
1	17	13	100	76
2	17	13	100	76
3	17	15	100	88
4	17	15	100	88
5	13	13	76	100
6	14	14	82	100
7	14	7	82	50
8	13	12	76	92
9	8	7	47	88
10	8	6	47	75
11	14	13	82	93
12	13	12	76	92
13	9	8	53	89
14	void			
15	10	8	59	80
16	9	8	53	89
17	12	9	71	75
18	12	12	71	100
19	6	4	35	67
20	10	8	59	80

Responses. A reason for making the assessment anonymous was to protect individual identity and therefore encourage participants to attempt an answer even if they were uncertain. Anonymity thereby avoids embarrassment, but the participants were apparently still reluctant to attempt an answer when they were unsure. Particularly disappointing were the attempts at questions 9, 10, 13 and 16, which address the foundations of modern datums, something that should have been familiar to them prior to the course. In terms of the new material, participants were generally more comfortable with the practicalities tested under questions 11, 12, 17 and 18 and definitions covered in the first 4 questions.

There are two instances where correct responses are less than 75%. The difficulty with question 7 is most peculiar, any surveyor should know the difference between an azimuth and a bearing, and a lot more than half of the class came from a surveying background. The poor response to question 19 is much more understandable, material was covered within the course, but this question was at the most complex level of the content, hence this question was challenging.

Observations

For future reference there are a number of points that follow from this experience, particularly relating to the audience. These observations were made while working with the participants during practical exercises:

- Senior surveyors working in the government sector operate primarily within cadastral systems. Considerable time has elapsed since their academic study and there is a lack of recent work experience in broader surveying components such as geodetic survey and mapping together, and in associated IT skills. It is unfortunate that these people are in a position to propose and implement change, but may be reluctant to operate beyond their zone of comfort.
- Recent graduates working in surveying demonstrated an understanding of the concepts in geodesy and mapping that are still fresh in their mind, and they had good IT skills with specialist software. However, these people are not in a position of authority necessary for implementation of change in policy.
- Those working in land management were generally lost in the content. While they work with spatial data they lack formal education or specialist work based skills in relevant aspects of surveying. There was one exception, a recent graduate in Civil Engineering who seemed to be enlightened. While lacking in specialist background the engineering education and aptitude of the individual enabled an appreciation for the material.
- Participants working in GIS were most appreciative of the material. In spite of their educational background, these people are working with spatial data in a mapping sense. They appreciate the geodetic reference frames that they are working in and are familiar with the use of GNSS equipment to acquire data. The material covered offered explanations to problems that they encounter within their work and their level of IT skills with specialist applications dealing with spatial data is excellent.

In conclusion, and for future reference, it is the GIS community working with spatial data at a national level who benefitted most from this course. Furthermore, the development of NSDI's will be driven by this community. The NSDI will eventually lay down the defining standards for all national data and all government offices dealing with such data will have to comply. It is suggested that representatives from this group be selected for future workshops.

PHOTOS


Universal time
Capacity Building
Course on Geodesy

APPENDIX

Fundamentals of Geodesy

End of course assessment

This test is intended to determine the level of appreciation of knowledge available within the region. Responses will be treated as confidential and used for internal purposes only.

1. How does a celestial reference system differ from a terrestrial reference system?

……

2. What is the primary purpose for acquiring gravity data locally?

……

3. What is a gravity anomaly?

……

4. How is the geoid defined?

……

5. What are the components that define a traditional geodetic datum?

……

6. What is the deflection of the vertical?

……

7. How is an azimuth difference from a bearing?

……

8. In terms of a map projection, what is a scale factor?

……

9. How do ITRF's accommodate tectonic motion?

……

10. How might a local connection to an ITRF be established?

……

11. What factors are considered in establishing a CORS stations? (provide a list of words)

……

12. What advantages does VRS offer over RTK?

……

13. In addition to active and passive CORS, there is still a need to maintain local monumented control, why?

……

14. What advantages does VRS offer over RTK?

……

15. How is a local datum for surveying and mapping established under ITRF?

……

16. How might a geoidal model support development of a national vertical datum?

……

17. When would a 2 dimensional affine transformation be used?

……

18. What are the 7-parameters associated with a Bursa-Wolf transformation?

……

19. How do transformations accommodate motion between reference frames?

……

20. What is the motivation towards adopting international standards for georeferencing of spatial data?

……