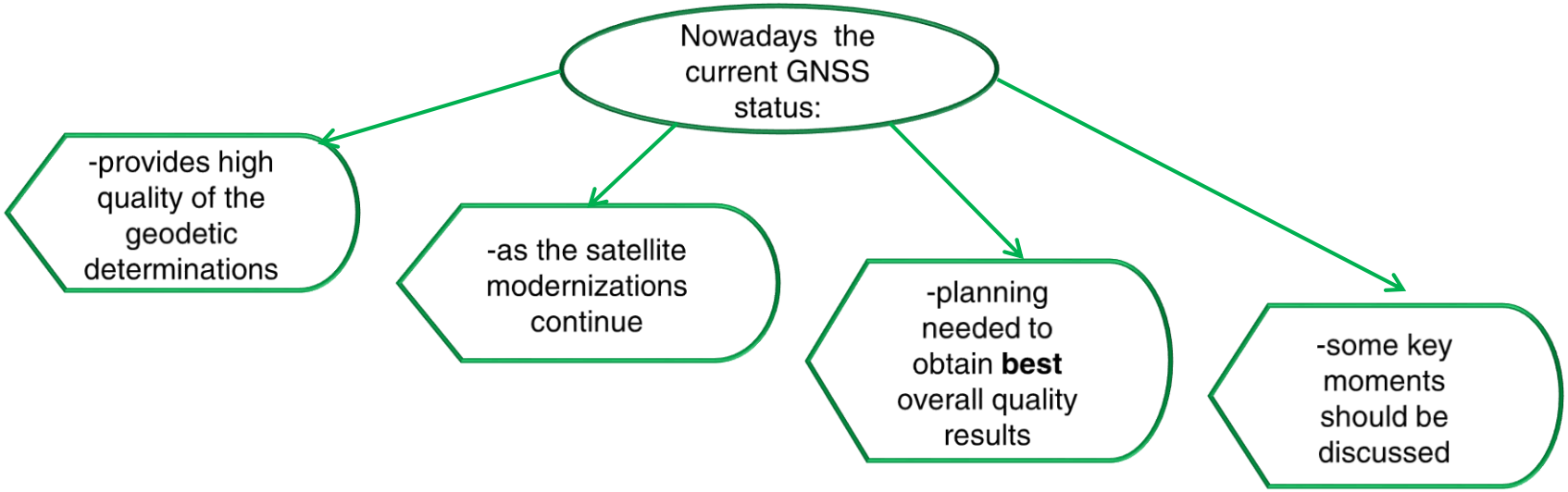
Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

Dr. M. Sc. **Gintcho Kostov, Bulgaria**
"GEO ZEMIA" Ltd.

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

1. Introduction



www.geozemia.com

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

2. Tasks of this paper

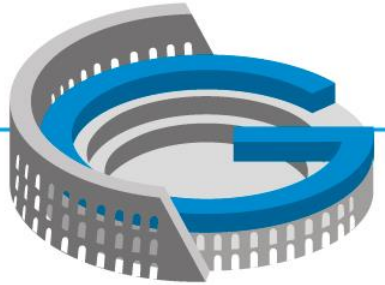
To be analysed:

– How much would be the improvement in the quality of the GNSS determinations by the created survey schedule?

– Will there be a (significant) change in the values of the quality criteria between the "**worst**" and "**best**" time frames?

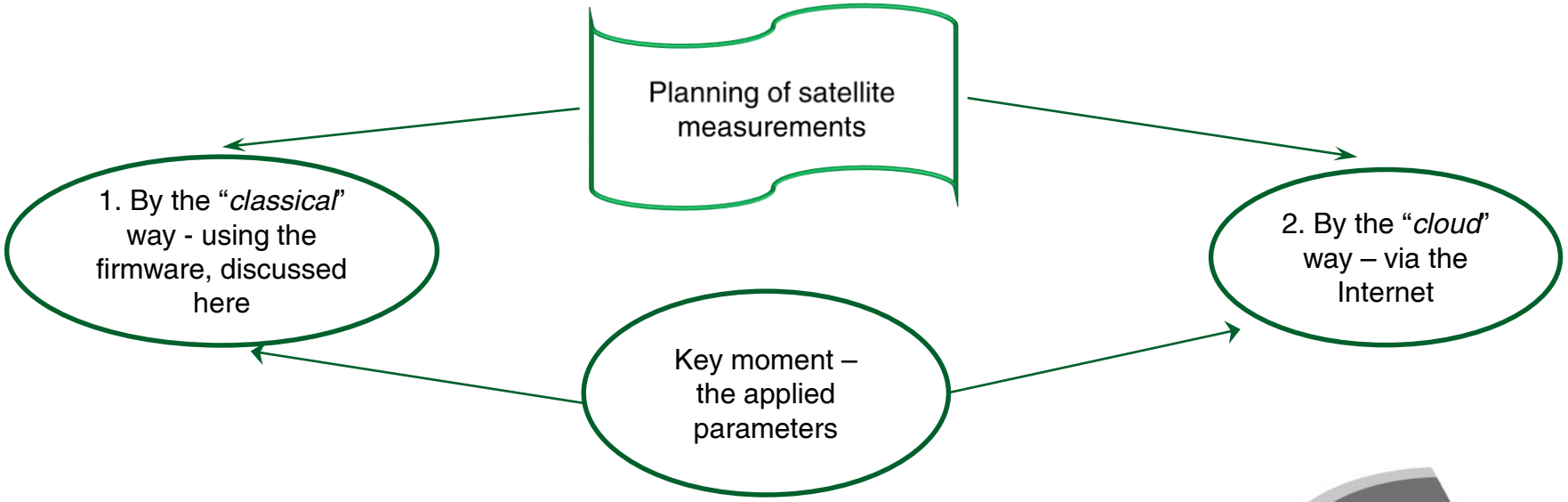
–Will the productivity be decreased?

www.geozemia.com



Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

3. Possible ways to do planning of GNSS measurements



www.geozemia.com

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

4. PRACTICAL ASPECTS AND PARAMETERS OF THE GNSS SYSTEM

Used methodology in the study:

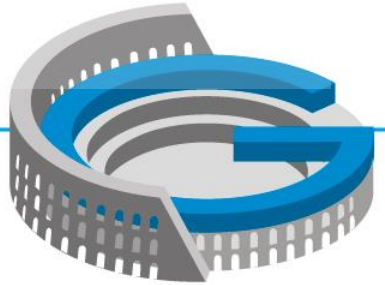
I. Type of the survey. Fast static mode was used. The spatial chords were chosen according to the following conditions:

1. **Reference**. One and the same reference point was used;
2. **Lengths of the chords** - up to **5** km, up to **10** km, up to **20** km, up to **30** km.
3. **Rovers**. - Placed on points from the existing geodetic network (on close proximity to major roads), which have clear horizon.

II. Previous experiments. Certain values of the parameters were applied in the GNSS system, according to author's results and conclusions in other tests.

III. Factors. For the practical implementation were taken into account the following key moments:

1. **The safety** - the measurements were conducted during daylight;
2. **The productivity** - the length of the sessions was set to a reasonable amount of time;
3. **The convenience** - each rover was placed on point with easy access by car.



Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

5. CONDUCTED PLANNED GNSS MEASUREMENTS

Four spatial chords were subject of quality assessment:

1. RT 22 (Kaloianovec) – length of **2.8** km.
2. GT 527 (Bogomilovo) – length of **9.1** km.
3. RT 1829 (KEN) - length of **17.4** km.
4. GT 547 (Oriahovica) - length of **28.5** km.

The experiment was divided into four cycles of GNSS measurements:

I. First cycle –
Provides *"best"* quality conditions for chords "Kaloianovec" and "Oriahovica".

"Worst" conditions - for chords "Bogomilovo" and "KEN".

II. Second cycle –
Consists of *"worst"* quality conditions for chords "Kaloianovec" and "Oriahovica".

"Best" time-window for chords "Bogomilovo" and "KEN".

III. Third and fourth cycles –
The chord "Bogomilovo" was studied using ***"best"*** and ***"worst"*** time-windows for GNSS measurements.

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

5. CONDUCTED PLANNED GNSS MEASUREMENTS

Note: Under the term "the worst time-window in the day" should be understood a time-span when **minimum number of satellites** were visible and **maximum value for GDOP** was predicted.

The term "the best time-window in the day" denotes a period of the day, when **maximum number of satellites** were visible and **minimum value for GDOP** was predicted.

www.geozemia.com

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

6. USED CRITERIA FOR OVERALL QUALITY ASSESSMENT OF THE CONDUCTED GEODETIC MEASUREMENTS

In this study the following quality criteria were used:

a) Quality in position and height M_{3D} ;

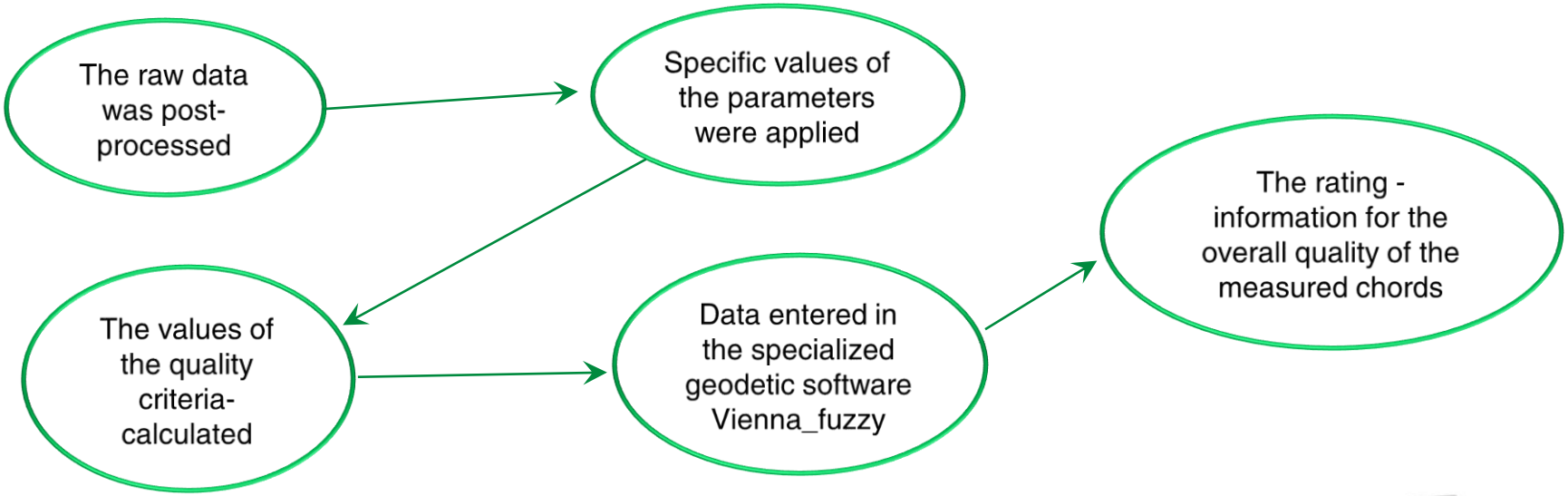
b) Elements of the co-variance matrix for the chord: Q_{xx} Q_{yy} Q_{zz} ;

c) Number $Gdop(\max)$;

d) Number $Pdop(\max)$.

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

7. PROCESSING OF THE QUALITY CRITERIA, USING FUZZY LOGIC



In this specific study, **the bigger** the value of the rating, **the better** the overall quality of the chords.

www.geozemia.com

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

7. PROCESSING OF THE QUALITY CRITERIA, USING FUZZY LOGIC

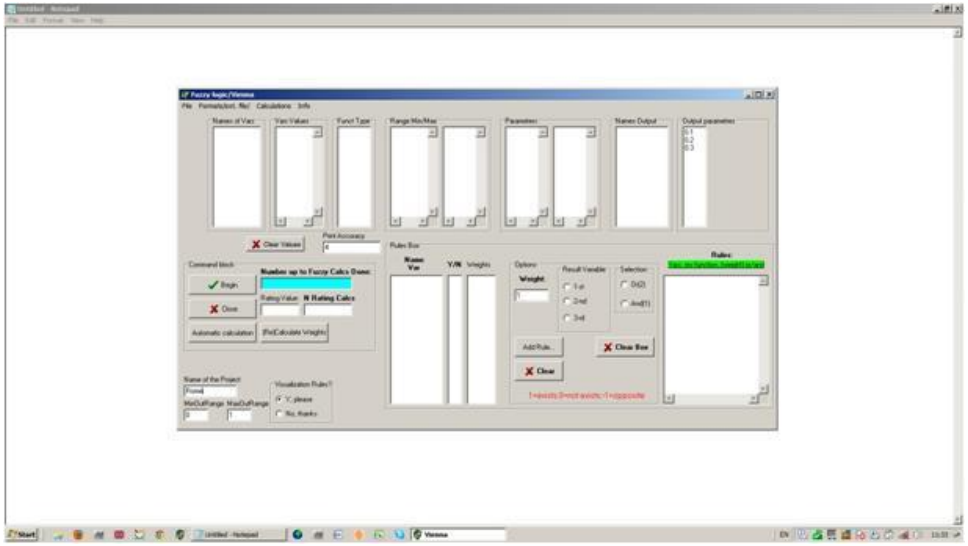


Fig. 1 – Window from specialized geodetic software Vienna_fuzzy.

www.geozemia.com

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

8. ANALYSIS OF THE RESULTS

The results - the rating values by Vienna_fuzzy for the overall quality assessment:

I. First cycle, Table 1

from GNSS planning	remote station	Kaloianovec	Bogomilovo	KEN	Oriahovica
	length [km]	**2.8**	**9.1**	**17.4**	**28.5**
	date and time	2.12.2012 14:26	2.12.2012 13:11	2.12.2012 12:26	2.12.2012 11:21
	number satellites	23	18	18	23
	GDOP	1	1.2	1.3	0.9
→	**rating**	**0.78**	**0.53**	**0.52**	**N/A**

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

8. ANALYSIS OF THE RESULTS

II. Second cycle, Table 2

	remote station	Kaloianovec	Bogomilovo	KEN	Oriahovica
	length [km]	**2.8**	**9.1**	**17.4**	**28.5**
from GNSS planning	date and time	02/18/2012 16:27:04	02/18/2012 13:48:54	02/18/2012 10:47:03	02/18/2012 12:02:03
	number satellites	18	23	23	18
	GDOP	1.2	0.9	0.9	1.2
	rating	**0.75**	**0.56**	**0.62**	**0.54**
	differences in rating	0.03	0.03	0.10	N/A

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

8. ANALYSIS OF THE RESULTS

III. Third and fourth cycles, Table 3

	remote station	Bogomilovo	Bogomilovo
	length [km]	**9.1**	**9.1**
from GNSS planning	date and time	02/19/2012 11:55:01	02/19/2012 10:56:08
	number satellites	18	23
	GDOP	1.2	0.9
	rating	**0.56**	**0.63**

→ difference in rating - **0.07** – ***same*** *overall quality*

www.geozemia.com

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

8. ANALYSIS OF THE RESULTS

Based on the GNSS planning and according to the calculated rating values it could be summarized:

I. First and second cycles

a) Chords with lengths of 2.8 km. and 9.1 km.:
The difference between the rating values is **0.03.**
It could be noted that the geodetic determinations have **similar overall quality.**

b) Chord with length of 17.4 km.:
The final result from the analysis - difference of **0.10** between the rating values.
It denotes **slight improvement** in the overall quality of the chord.

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

8. ANALYSIS OF THE RESULTS

II. Third and fourth cycles

The planned GNSS measurements for these cycles were conducted exclusively for a chord - up to **10 km.**

The rating values from third and fourth cycles differ with **0.07.**

No significant difference in the quality of the chord was observed for these cycles.

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

9. CONCLUSIONS

According to the results and analysis, it could be concluded that **very small differences** in the overall quality of each measured chord were calculated between the relevant cycles.

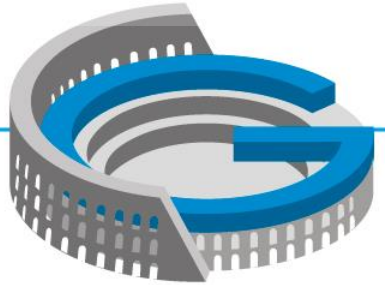
The points to discuss, could be answered in the following way:

– There is a small improvement in the overall quality of the chords between *"the worst time-window in the day"* and "*the best time-window in the day"*. The difference in the rating is within the interval **[0.03-0.1].**

– The calculated values of the quality criteria for each chord and cycle vary. This was one of the main reasons to apply Fuzzy logic to produce objective results.

– It should be noted, that the productivity was strongly decreased, as strict schedule for conducting of the measurements was used.

For specific projects or when explicitly required, planning should be used in order to produce the **maximum possible overall quality.**



Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

9. CONCLUSIONS

According to the recent improvements of the IT in the GNSS, for geodetic applications, which do not require very high level of accuracy, planning may not give significant improvement in the overall quality of the results.

It would decrease the productivity of the GNSS determinations.

Future work and experiments could include study and analysis at places with existing obstructions in order to test their level of influence on the results from the geodetic measurements.

www.geozemia.com

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

REFERENCES:

Kostov, G. 2010. Assessing of the Overall Quality of GNSS Determinations, Using Specific Values of Parameters. Third International Conference on Cartography and GIS, Nessebar, Bulgaria.

Kostov, G. 2007. Assessment of the Quality of Geodetic Networks Using Fuzzy Logic. Geowissenschaftliche Mitteilungen Heft Nr. 78. Pages 4-19. Wien. Schriftenreihe der Studienrichtung Vermessung und Geoinformation Technische Universitat Wien. ISSN 1811-8380.

Kostov, G. 2010. Some Studies on the Quality of GNSS Determinations Under Specific Conditions. FS 1H - GNSS CORS Networks - Positioning Infrastructure, Analysis and Applications I. FIG Congress 2010 Facing the Challenges – Building the Capacity Sydney, Australia. ISBN 978-87-90907-87-7.

Kostov, G. 2009. Using of Fuzzy Logic for Some Studies over GNSS Determination in fast Static mode. University of Architecture, Civil Engineering and Geodesy. International Scientific-Applied Conference. Sofia, UACEG 2009. ISSN 1310-814X.

Wellenhof, B., Herbert Lichtenegger, James Collins, 2002, GPS Theory and practice, Springer-Verlag/Wien, pp183, Wien, Austria (in Bulgarian).

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

REFERENCES:

WEB:

http://asp.ashtech.com/wmp/
http://en.wikipedia.org/wiki/GLONASS
http://maic.jmu.edu/sic/gps/planning.htm
http://www.ask.com/wiki/GLONASS#Renewed_efforts_and_modernization
http://www.ewdn.com/2011/06/02/glonass-sets-goal-to-exceed-gps-accuracy-twofold-vice-pm-guarantees-free-service-worldwide/
http://www.gpsworld.com/survey/satellite-gps-glonass-sbas-mission-planning-8635
http://www.isprs.org/proceedings/XXXVIII/4-W13/ID_10.pdf

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

REFERENCES:

WEB:

http://www.navcomtech.com/Support/Tools/satellitepredictor/main.cfm

http://www.navleader.com/GGE2012_LectureNotes/20.Lecture110322_GGE2012_GPS03_PlanningGPSsurvey_byAhn_2pages.pdf

http://www.navleader.com/GGE2012_LectureNotes/21.Lecture110324_GGE2012_GPS04_Tutorial_byAhn_2pages.pdf

http://www.oregon.gov/ODOT/HWY/GEOMETRONICS/docs/presentations/2-10-11_Olsen_Armstrong-Part4_GNSS_Survey_Planning.pdf?ga=t

http://www.pods.org/assets/file/PODS_UserConference_FutureofHigh-AccuracyGPS_2011.pdf

http://www.romdas.com/romdascd/info/faq/GPS%20Survey%20Planning.pdf?token=d3d4138d99e1556bdfb8cbbe8eb1260e99ffc63e|1328729771#PDFP

http://www.trimble.com/GNSSPlanningOnline/#/Settings

Study on the Overall Quality of the Planned fast Static GNSS Measurements, if Certain Values of the Parameters are Applied in the System, Using Fuzzy Logic

Thank you for your attention!

www.geozemia.com