

Displacement field estimation from GPS measurements in the Volvi area

by

*I. DOUKAS, A. FOTIOU, I. M. IFADIS, K. KATSAMBALOS,
K. LAKAKIS, N. PETRIDOU – CHRYSOHOIDOU, C. PIKRIDAS,
D. ROSSIKOPOULOS, P. SAVVAIDIS, K. TOKMAKIDIS
and I. N. TZIAVOS*

*Department of Geodesy & Surveying
Faculty of Rural & Surveying Engineering
Aristotle University of Thessaloniki, Greece*

*Laboratory of Geodesy
Faculty of Civil Engineering
Aristotle University of Thessaloniki, Greece*

Introduction

- The Volvi area is located at the northern part of Greece, about forty kilometers from the city of Thessaloniki.
- The last large scale ($M=6.5$) earthquake occurred on June 20, 1978 followed by a series of aftershocks

Monitoring Network - 16 pillars 11 measurement epochs

- 6 epochs of classical measurements: (angles and distances)
1979, 1981, 1982, 1983, 1989 and 1990
- 5 epochs of GPS measurements:
1994, 1995, 1996, 1997 and 2003

The monitoring network at the Volvi Area



Measurement Scheme

- Five independent GPS campaigns between 1994 and 2003.
- Each campaign lasted from five to nine consecutive days. Two to three sessions within a day.
- Dual frequency GPS receivers, Leica and Ashtech were used. Baseline recording time varies from two to ten hours with a 30-sec. observation rate & 15° cut-off angle.

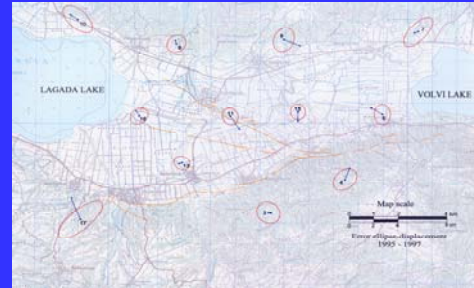
ANALYSIS AND RESULTS OF GPS DATA

1. Comparison between epochs

is obtained by the optimal fitting of each epoch coordinates to the coordinates of a reference epoch, applying the similarity transformation.

Id	Displacements			Error Ellipses			Years
	dx (cm)	dy (cm)	dz (cm)	a (cm)	b (cm)	θ (grad)	
7	0.09	-0.5	0.5	0.72	0.48	182.9	1994-1995
	0.48	0.41	0.63	0.96	0.72	177.7	1995-1996
	-0.72	-0.05	0.72	0.72	0.48	176.41	1996-1997
	1.06	-0.14	1.09	1.2	0.72	180.21	1997-2003
33	0.52	-0.92	1.05	0.72	0.72	182.13	1994-1995
	0.05	-0.77	0.77	0.96	0.72	174.75	1995-1996
	-0.26	1.2	1.23	0.22	0.48	170.54	1996-1997
	0	-0.59	0.59	0.72	0.48	180.02	1997-2003
5	0.16	-0.07	0.18	1.2	0.72	181.73	1994-1995
	0.42	0.28	0.5	1.2	0.72	179.98	1995-1996
	-0.67	0.166	0.7	0.48	0.48	174.53	1996-1997
16	0.22	0.98	0.24	0.96	0.72	181.95	1994-1995
	-0.16	-0.32	0.36	0.96	0.72	179.13	1995-1996
	-0.46	0.29	0.54	0.72	0.48	179.64	1996-1997
	0.23	-0.21	0.32	0.72	0.48	177.55	1997-2003
10	0.56	-0.25	0.56	1.92	0.96	189.32	1994-1995
	-0.64	0.55	0.85	2.16	0.96	188.44	1995-1996
9	0.96	0.7	1.19	1.2	0.72	185.96	1994-1995
	-0.61	-0.07	0.61	0.96	0.72	184.6	1995-1996
	-0.32	-0.15	0.36	0.72	0.48	183.33	1996-1997
	0.4	-0.12	0.43	1.2	0.48	173.98	1997-2003
15	0.53	-0.09	0.53	0.72	0.48	183.76	1995-1996
	-0.99	0.41	1.2	0.48	0.48	175.36	1996-1997
	0.83	-0.14	0.85	0.96	0.48	180.36	1997-2003
17	1	0.25	1.03	0.72	0.48	172.97	1995-1996
13	-0.03	0.24	0.24	0.72	0.72	168.64	1995-1996
11	0.62	0.01	0.63	0.96	0.72	174.48	1995-1996
4	-1.82	-0.11	1.82	2.64	0.96	179.22	1996-1997
	0.67	0.17	0.7	0.72	0.48	178.94	1997-2003
1	-0.04	-0.21	0.32	0.72	0.48	180.79	1997-2003
32	0.47	-2.34	2.4	0.72	0.48	180.44	1997-2003
31	-1.06	-0.36	1.12	1.44	0.72	183.96	1997-2003
42	1.18	1.09	1.61	2.16	1.2	178.3	1997-2003
52	2.11	-0.11	2.12	1.44	0.96	183.57	1997-2003
53	1.12	-0.06	1.55	1.2	0.72	181.57	1997-2003
54	1.34	1.53	2.04	1.2	0.72	183.29	1997-2003

Coordinate difference vectors between 1995 and 1997



Coordinate difference vectors from 1994 to 2003



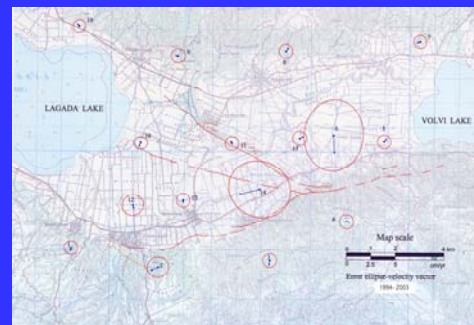
2. Simultaneous adjustment of all epochs and the velocity field estimation

Considering a homogeneous displacement field in time for the 5 GPS epochs point velocity vectors of the Volvi Network are estimated with their confidence ellipses.

Velocity estimation from the 5-GPS epochs 1994,1995,1996,1997 and 2003

Id	Velocities (cm/year)		
	Δ N	Δ E	Δ W
7	0.15	0.18	0.11
3	0.08	0.04	0.04
5	-0.71	-0.17	-0.60
16	-0.71	-0.32	-0.70
10	0.13	0.02	0.16
9	0.22	0.10	0.25
1	0.47	0.07	0.11
4	0.70	0.32	0.48
32	0.68	0.37	0.14
42	-0.15	0.14	0.13
15	0.21	0.15	0.12

Velocity vectors and their confidence ellipses (1-a=0.95)



Concluding remarks

- The analysis of the GPS data shows that there is a slight relaxation of the deforming body in general, with the exception of a few points.
- Using a linear model for the velocity field the velocity vectors are within their confidence error ellipses. This result enforces that the area is geotectonically non active.