ECONOMIC GROWTH OF TUSAGA-Aktif

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ABSTRACT:

Officially the unique high precision positioning system is CORS-Tr (TUSAGA-Aktif) in Turkey. CORS-Tr has 146 permanent GNSS station and two control centers. Today there are more than 10.000 individual users who are paying subscription, GNSS data, positioning services monthly or annually since 2011.

In every month More than 30 users joined to CORS-Tr from different sector. User sector, if we categorize surveying, mining, construction, licensed surveyor, etc. But in this paper we will use five categories as Land Registry and Cadastre, Public Institutions, Municipalities, Universities and Licensed Surveyors to determine economic growth of CORS-Tr. Following years increasing rate of user's monthly will be much more higher by establishing additional permanent GSNSS station due to prevent extrapolation. This paper presents CORS-Tr economic growth estimation by last three years log data analysis using valuation approach.

KEY WORDS: CORS-Tr, TUSAGA-Aktif, GNSS Networks, User Log Data, Economic Growth of GNSS networks

1. INTRODUCTION

TUSAGA-Aktif (Continuously Operating Permanent GNSS Reference System –CORS-Tr) is unique GNSS network in the Turkey where established 146 GNSS reference stations including Turkish Republic of Northern Cyprus. Distances between reference stations are around 80-100 km. More than 10.000 user have subscription to use network correction to point positioning.

Two control centers of CORS-Tr are located in Ankara. Master control center operated by General Directorate of Land Registry and Cadastre (TKGM) and other operated by General Directorate of Mapping (HGM).

CORS-Tr operated within the cooperation with TKGM and HGM by executive board. Under the executive board TKGM is operating master control center including user management, reference station management and etc.. HGM is operating protocols with public institutions and other issues.

CORS-Tr System have five categories in user database; Land Registry and Cadastre, Public Institutions, Municipalities, Universities and Private Sectors..

Substantial technological advances have been made in recent years to improve the accuracy of the global positioning system. Today, precise positioning technology uses multiple frequency Global Navigation Satellite Systems (GNSS) receivers to achieve real-time or near real-time accuracy of two centimetres. This degree of accuracy opens up a range of new commercial applications for improving production and processing efficiency in industries such as agriculture, mining and construction [1].

CORS data are used extensively for traditionally horizontal positioning (latitude and longitude), including asset inventory as in locating property boundaries, and for establishing the relative location of natural and manmade structures such as rivers, roads, buildings, water pipes and power lines. CORS data also allows monitoring of the motion of critical structures such as dams, bridges and nuclear power plants. The use of CORS for determining vertical (ellipsoid heights) information is growing, and accuracy needs are getting stricter. CORS plays a central role in maintaining the integrity of the National Spatial Reference System in all three dimensions [2].

Improved efficiency through use of positioning technology in the agriculture, mining, survey and land development, construction, utilities, and transport sectors, reduces costs and has the potential to reduce prices to consumers. While these impacts are more broadly captured in the economic results they are nevertheless important benefits to society in general [3].

This paper presents economic contribution of TUSAGA-Aktif by using valuation technics apart from its official incomes and outcomes.

1.1 CORS-Tr cost, usage fee, incomes and outcomes

CORS-Tr Project was completed in 2008 with a cost of 2.5 million USD including academic researches by funding of TUBITAK.

Operational Costs of CORS-Tr System includes;

- Hardware Costs; GNSS Stations and Control Center (CC)
- Software Costs; CC Software and GNSS Firmware
- Maintenance / Repair Costs; Changing station locations, maintenance, repairing
- Communication Costs; 2XMetro internet and 146 VPN Internet connections
- Promotion costs; Seminars, symposiums, trainings, etc. for CORS-Tr

Expensed cost, usage fees, user and incomes of CORS-Tr are shown following figures [4-5].

YEAR	EXPENSE VARIETY					
	Hardware	Software	Maintenance	Promotion	Communication	TOTAL
2010	$23.000,00	$0,00	$15.000,00	$0,00	$60.000,00	$98.000,00
2011	$7.000,00	$0,00	$0,00	$0,00	$125.000,00	$132.000,00
2012	$413.000,00	$0,00	$25.000,00	$0,00	$112.000,00	$550.000,00
2013	$6.000,00	$0,00	$0,00	$35.000,00	$319.000,00	$360.000,00
2014	$458.000,00	$176.000,00	$0,00	$0,00	$288.000,00	$922.000,00
2015	$0,00	$0,00	$0,00	$0,00	$305.000,00	$305.000,00
2016	$59.000,00	$0,00	$0,00	$0,00	$211.000,00	$270.000,00
2017	$248.000,00	$0,00	$37.000,00	$0,00	$265.000,00	$550.000,00
TOTAL	$1.214.000,00	$176.000,00	$77.000,00	$35.000,00	$1.685.000,00	$3.187.000,00

Figure -1 CORS-Tr cost annually

SERVICE TYPE	DATA TYPE	PRICE*	EXPLANATION
SUBSCRIPTION	-	$30	ONCE
RTK SERVICES	NETWORK-RTK	$20	MONTHLY
		$150	ANNUAL
	NETWORK-DGPS	$10	MONTHLY
		$75	ANNUAL
RINEX DATAS	RINEX 1 SECOND	$0,2	STATION/HOUR
	RINEX 30 SECONDS	FREE	STATION/DAY

Figure – 2 CORS-Tr usage fees

YEAR	Nr of USERS	RTK FEE (USD)	INCOME (X1000 USD)
2011	2900	500	1900
2012	3300	410	1700
2013	3900	395	1600
2014	5200	357	1500
2015	6300	277	1600
2016	7500	258	1500
2017	9000	215	1400

Figure – 3 CORS-Tr Users, fees and incomes annually

2. ECONOMIC GROWTH OF TUSAGA-AKTIF

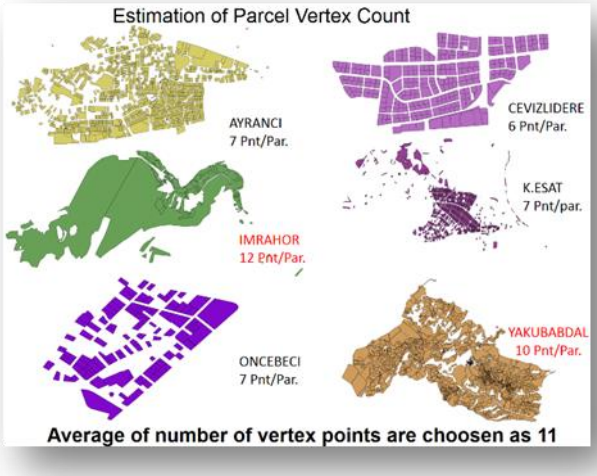
2.1 Methodology

User measurements 2015, 2016 and 2017 in SQL database is considered to estimate of TUSAGA-Aktif economic growth. For this purpose firstly we described a parcel average vertex count in Turkey from some examples. Then user measurements converted cadastral parcels counts in different categories. To estimate user measurement values parcel values we use officially declared cadastral detail measurements price, on site cadastral parcel application price, land use conversion price and to show parcel position price. Newly joined GNNS equipment

in every year is also considered to estimate TUSAGA-Aktif economic growth. Valuation criteria is explained in following section.

2.2 Valuation criteria

Estimation of parcel vertex count is based different cadastral data which are described urban area and rural area. Our sample and vertex count is shown following figure.



To estimation of parcel detail measurement prices; We refered to forest cadastral works contracts and cadastral renowation contracts by GDLRC in 2015,2016 and 2017. Average of decleared parcel detail measurements is 20 TL/Parcel in 2015, 14 TL/Parcel in 2016 and 7 TL/Parcel in 2017.

Cadastral Parcel Application, Land Use Conversion and Show Parcel Position works are done by licensed surveyors (LIHKAB) in Turkey. Officially decleared Licenced surveyor work process prices shown below used as valuation criters.

PROCESS NAME	2015 PRICE TL	2016 PRICE TL	2017 PRICE TL
PARCEL APPLICATION	381	402	418
LAND USE CONVERSION	139	146	152
SHOW PARSEL POSITION	121	128	133

Aditionally to joined GNSS to TUSAGA-Aktif system in every year is considered to estimated TUSAGA-Aktif ecomonic growth.

SECTOR GNSS	2015 GNSS	2016 GNSS	2017 GNSS
GDLRC	72	0	65
PRIVATE SECTORS	767	838	1166
PUBLİC INS.	225	109	133
MUNICPALITIES	266	149	113
UNIVERCITIES	19	17	18
TOTAL	**1349**	**1113**	**1495**

User measurement in 2015,2016 and 2017 are shown following table in categorized structure.

CATEGORIES	POINTS 2015	POINTS 2016	POINTS 2017
PRIVATE SEC.	71,414,664	67,787,520	101,555,807
GDLRC	7,346,346	2,332,920	3,069,500
MUNICIPALITIES	5,954,490	5,396,568	8,068,438
PUBLIC INST.	4,325,358	4,827,024	14,353,765
UNIVERCITIES	321,072	484,464	472,444
TOTAL	**89,361,930**	**80,828,496**	**127,519,954**

2.3 Valuation of TUSAGA-Aktif Measurements

TUSAGA-Aktif measurements are valued by declared criteria year by year (2015, 2016 and 2017) and shown following pictures.

TUSAGA-Aktif System 2015 Economic Growth						
	PRIVATE	GOVERM.	MUNICIPAL	GDLRC	UNIV.	TOTAL
NEW JOINED GNSS	767	225	266	72	19	1.349
MESURED POINTS	71.414.664	4.325.358	5.954.490	7.346.346	321.072	89.361.930
COROSPONDING PARCELS	6.492.242	393.214	541.317	667.850	29.188	8.123.812
ECONOMIC GROWTH 2015						
KADASTRAL MEAS.VALUE	129.844.844	7.864.287	10.826.345	13.356.993	583.767	162.476.236
PARCEL APPLICATOIN VALUE	2.473.544.271	149.814.673	206.241.881	254.450.711	11.120.767	3.095.172.303
LAND USE CONV.VALUE	902.421.663	54.656.797	75.243.101	92.831.099	4.057.183	1.129.209.843
SHOW PARCEL POS. VALUE	785.561.304	47.578.938	65.499.390	80.809.806	3.531.792	982.981.230
AVERAGE VALUE	**1.072.843.021**	**64.978.674**	**89.452.679**	**110.362.152**	**4.823.377**	**1.342.459.903**
2015 GNSS VALUE	15.340.000	4.500.000	5.320.000	1.440.000	380.000	26.980.000
2015 EKONOMIC GROWTH	**1.088.183.021**	**69.478.674**	**94.772.679**	**111.802.152**	**5.203.377**	**1.369.439.903**

TUSAGA-Aktif System 2016 Economic Growth						
	PRIVATE	GOVERM.	MUNICIPAL	GDLRC	UNIV.	TOTAL
NEW JOINED GNSS	838	109	149	0	17	1.113
MESURED POINTS	67.787.520	4.827.024	5.396.568	2.332.920	484.464	80.828.496
COROSPONDING PARCELS	6.162.502	438.820	490.597	212.084	44.042	7.348.045
ECONOMIC GROWTH 2016						
KADASTRAL MEAS.VALUE	86.275.025	6.143.485	6.868.359	2.969.171	616.591	102.872.631
PARCEL APPLICATOIN VALUE	2.477.325.731	176.405.786	197.220.031	85.257.622	17.704.957	2.953.914.127
LAND USE CONV.VALUE	899.725.265	64.067.773	71.627.175	30.964.211	6.430.159	1.072.814.583
SHOW PARCEL POS. VALUE	788.800.233	56.169.007	62.796.428	27.146.705	5.637.399	940.549.772
AVERAGE VALUE	**1.063.031.564**	**75.696.513**	**84.627.998**	**36.584.427**	**7.597.276**	**1.267.537.778**
2016 GNSS VALUE	16.760.000	2.180.000	2.980.000	0	340.000	22.260.000
2016 EKONOMIC GROWTH	**1.079.791.564**	**77.876.513**	**87.607.998**	**36.584.427**	**7.937.276**	**1.289.797.778**

TUSAGA-Aktif System 2017 Economic Growth						
	PRIVATE	GOVERM.	MUNICIPAL	GDLRC	UNIV.	TOTAL
NEW JOINED GNSS	1.166	133	113	65	18	1.495
MESURED POINTS	101.555.807	14.353.765	8.068.438	3.069.500	472.444	127.519.954
COROSPONDING PARCELS	9.232.346	1.304.888	733.494	279.045	42.949	11.592.723
ECONOMIC GROWTH 2017						
KADASTRAL MEAS.VALUE	64.626.423	9.134.214	5.134.461	1.953.318	300.646	81.149.062
PARCEL APPLICATOIN VALUE	3.859.120.666	545.443.070	306.600.644	116.641.000	17.952.872	4.845.758.252
LAND USE CONV.VALUE	10.635.662.697	198.342.935	111.491.143	42.414.909	6.528.317	1.762.093.910
SHOW PARCEL POS. VALUE	1.227.902.030	173.550.068	97.554.750	37.113.045	5.712.277	1.541.832.171
AVERAGE VALUE	**3.946.827.954**	**231.617.572**	**130.195.250**	**49.530.568**	**7.623.528**	**2.057.708.349**
2017 GNSS VALUE	23.320.000	2.660.000	2.260.000	1.300.000	360.000	29.900.000
2017 EKONOMIC GROWTH	**3.970.147.954**	**234.277.572**	**132.455.250**	**50.830.568**	**7.983.528**	**2.087.608.349**

3. CONCLUSIONS

As a result of this investigation we easily can say TUSAGA-Aktif created 460 million dollars average economic growth annually in positioning/mapping sector. It is %0,054 of Turkey GDP. And TUSGA-Aktif saves 75 million TL annually in this sector.

YEAR	ECOGROWTH [TL]	ECOGROWTH [MIL.USD]	GDP [MIL.USD]	% of GDP
2015	1.369.439.903	460	860.000	0,054
2016	1.289.797.778	370	864.000	0,043
2017	2.087.608.349	550	851.000	0,065
AVE	**1.582.282.010**	**460**	**858.000**	**0,054**

On another hand, socio-cultural and socio-economic effects of TUSAGA-Aktif should be considered within the investigation later.

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