

QIBLA DETERMINATION BY USING GNSS: A CASE STUDY IN ÇORUM CITY

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WHY

It is necessary to orientate especially the sanctuaries of the world to a determined direction. Within this context, Muslims should face towards Ka'ba (that is the most sacred Muslim site in the world) in Mecca City of Saudi Arabia during their prayer obligatory. The direction that Muslims face towards during prayer is called qibla and a wall niche, known as mihrab, of the mosques should orientate towards the qibla direction. The angle of the qibla direction is not fixed and depends on the location on the world (Figure 1).

HOW

For the validation of the prayer, the direction of the qibla should be determined precisely. There are numerous studies in this field and qibla direction is determined with different equipment and computation methods by using different approvals and approaches. Qibla direction can be determined mainly with;

- using qibla time,
 - using qibla map,
 - using astronomical instruments such as astrolabe,
 - using trigonometric formula.

AIM

- In this study, qibla directions of selected mosques of Çorum City which were constructed in different periods (i.e. between 15th and 21th century) were determined by using GPS measurement, which is a widely used satellite-based point positioning system.
- In order to provide this, coordinates of two points on the direction of the mosque's wall representing the qibla direction were determined with satellite-based positioning method, i.e. GPS measurements and azimuth of qibla direction was calculated by using geodetic formula.

STUDY

- On the other hand, real qibla directions of each mosque were calculated by trigonometric formulas (Figure 3). Determined existing and calculated real qibla angles were compared and the differences were interpreted according to the Islamic criteria. Besides, these differences were interpreted for the accuracies of the approaches used for the determination of qibla during the period of the mosque constructions.

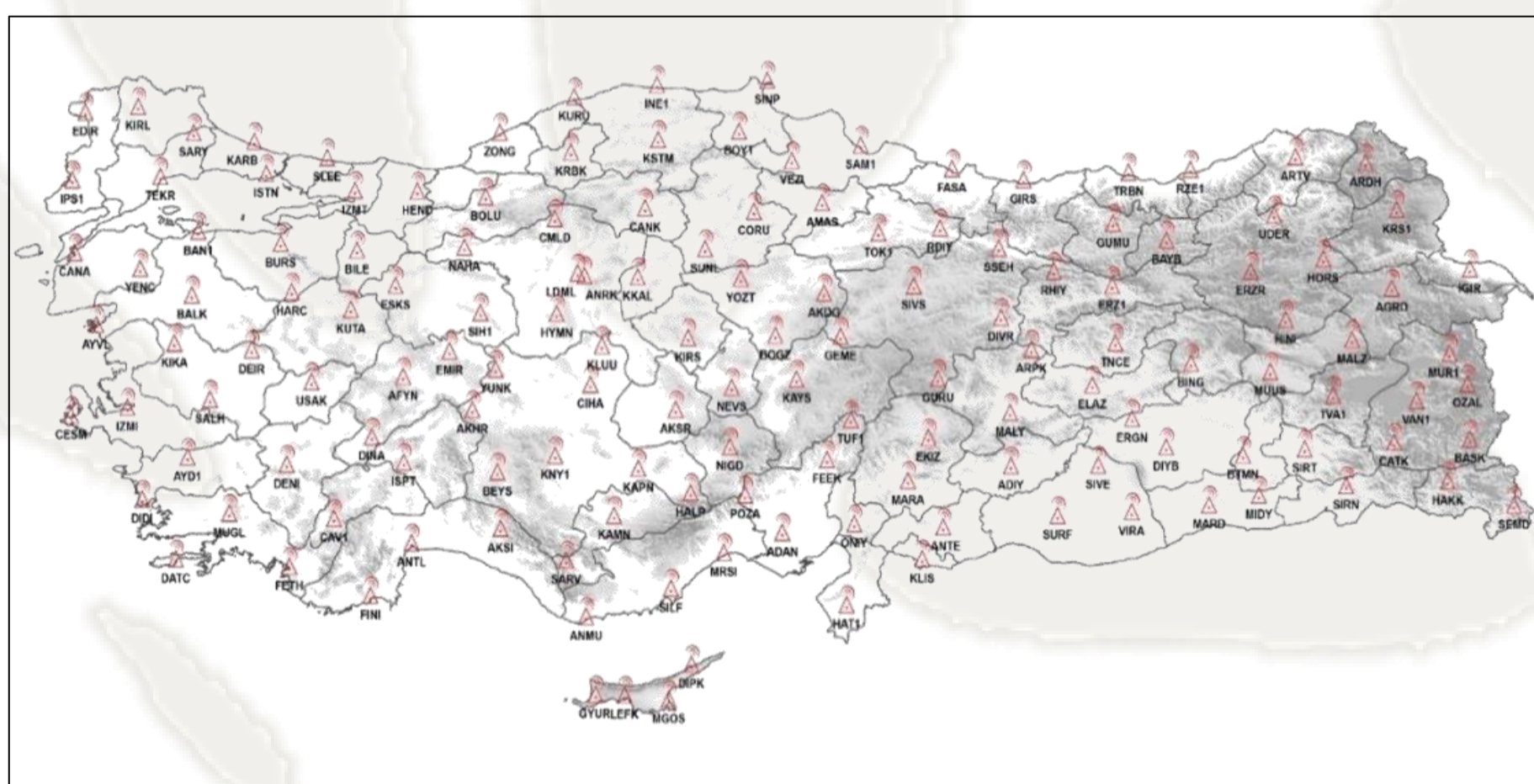


Figure 5. Location of TUSAGA-Aktif Reference Stations

Major developments in the world of informatics have led to the creation of different solutions with various algorithms and major changes in numerous professional fields as well as in GPS surveying. Although; in 1990's, it was necessary to obtain positioning with Global Positioning System (GPS) using at least two receivers; nowadays an accuracy of within centimeters level of positioning has become possible using single receiver and advanced techniques. One of which is Network-RTK used extensively in the world producing economical and rapid solutions to the users. Network-RTK systems have been set up to provide data collection, processing and transmission to users. In Turkey, CORS network later renamed as TUSAGA-Aktif Network put into service in 2009. The network consists of 146 reference stations with an average spacing of 70-100 km covering the entire country of Turkey including the Turkish Republic of Northern Cyprus (Figure 5).

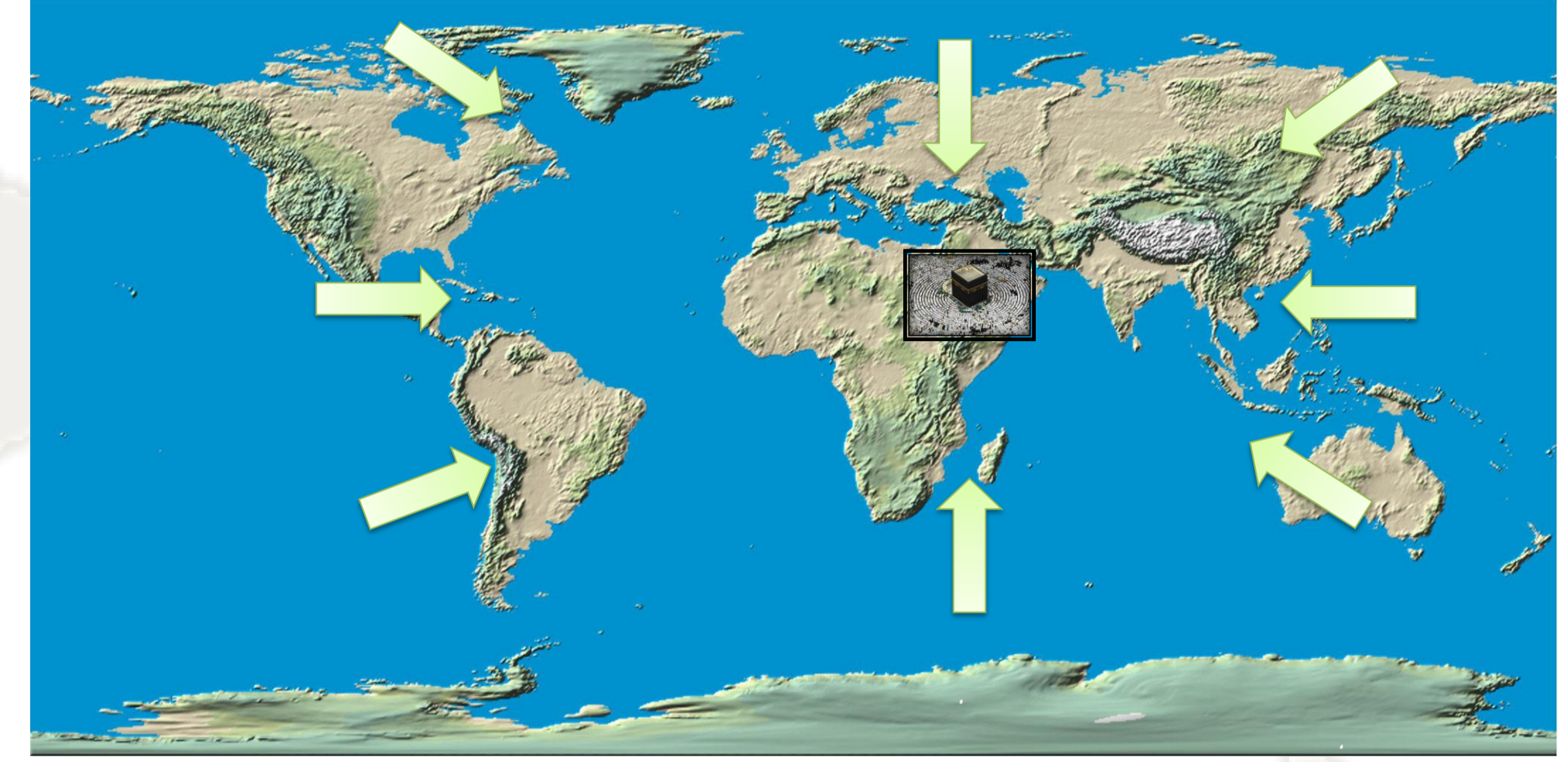


Figure.1 Schematic Representation of the Qibla Direction on the World.

The accuracy of each method is varied. However, the difference between the determined and real qibla direction should not exceed 45° (Figure 2).

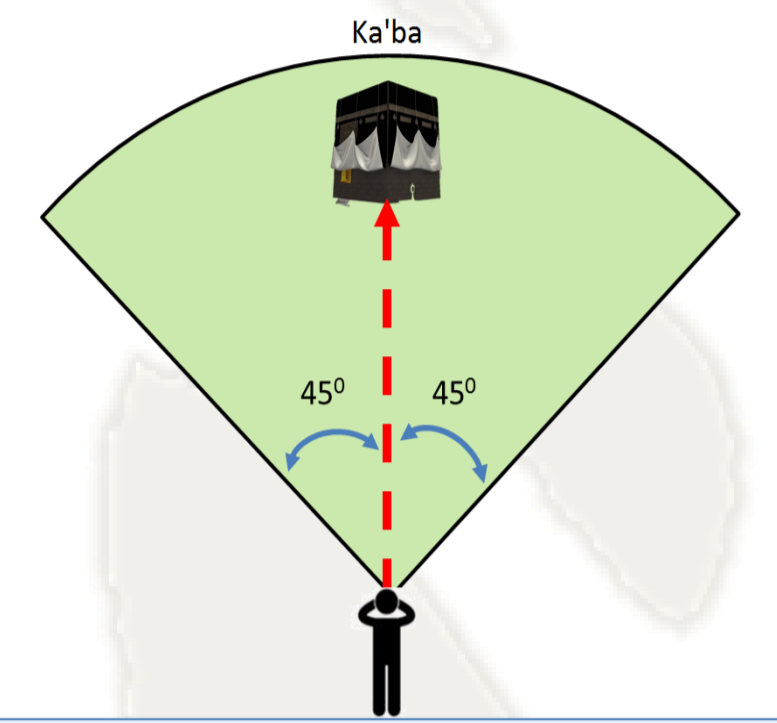


Figure.2 Permitted Declination Bound.

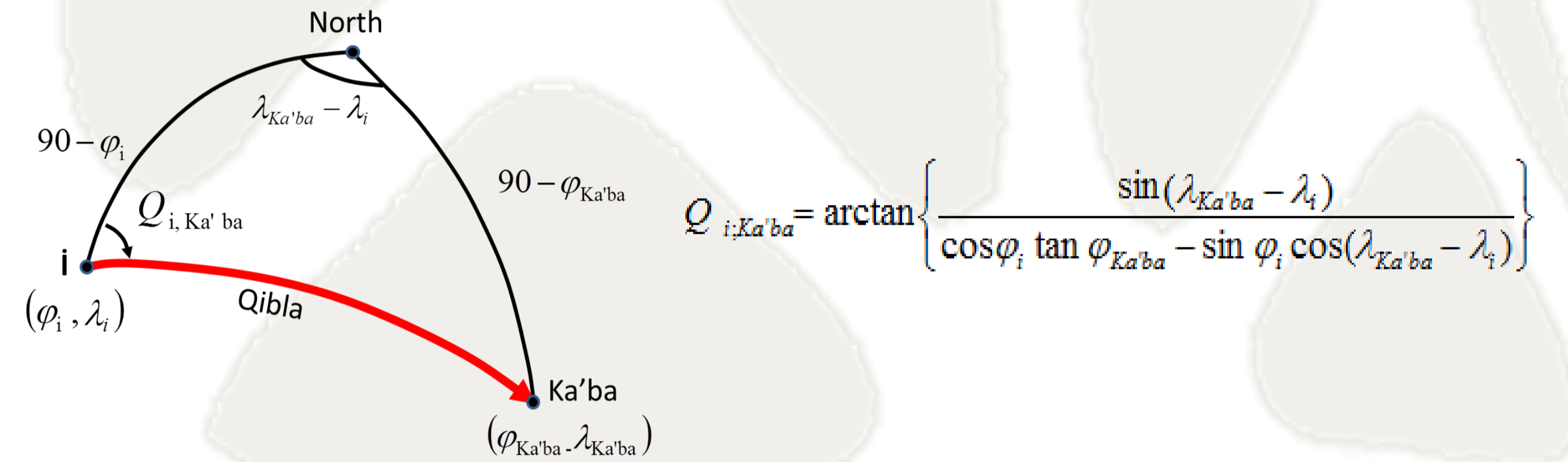


Figure.3 Qibla Angle on a Spherical Triangle and Formula

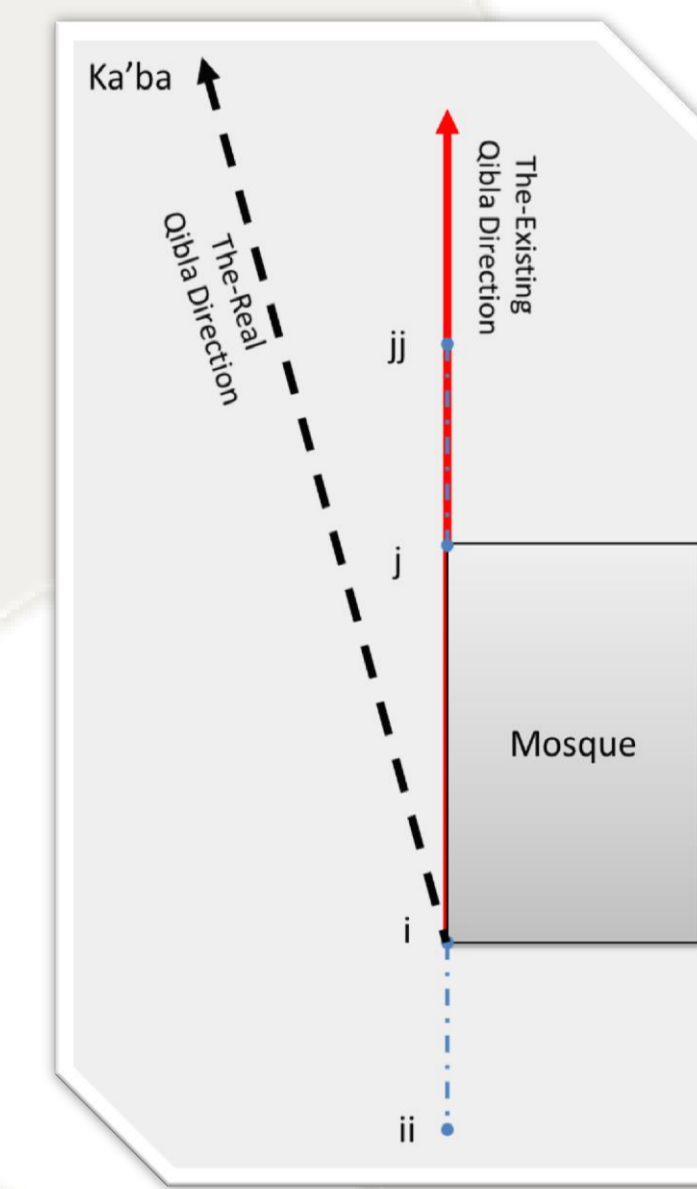


Figure.4 Measurement of Mosque Qibla Direction

Table 1. The Differences Between the Existing and Calculated Qibla Directions

Name	Year of Construction	Real Qibla Direction			Existing Qibla Direction			Differences		
		Degree(o)	Minute(')	Second(')	Degree(o)	Minute(')	Second(')	Degree(o)	Minute(')	Second(')
Mosque 1	1579	166	20	31	172	42	47	6	22	16
Mosque 2	1650	166	20	50	183	26	52	17	6	2
Mosque 3	1660	166	21	10	183	12	17	16	51	7
Mosque 4	1988	166	25	1	169	12	43	2	47	42
Mosque 5	1997	166	23	33	167	17	14	0	53	41
Mosque 6	2009	166	16	3	168	27	11	2	11	8
Mosque 7	2013	166	10	33	166	10	1	0	0	32

CONCLUSIONS

When the results given in Table 1 are examined, the existing Qibla directions of all mosques are acceptable according to the Islamic comment stated above. However, the differences at especially VeliPaşa, Kellegöz and Han mosques are respectively about 17,16 and 6 degree.

In the other hand, qibla directions of constructed mosques after the 2000s are highly accurate than former mosques.

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