

Maldives Bioenergy Feasibility Study – Scoping of Algal Biofuel Potential

The dependence on vast energy supply for functioning of modern economics has become essential. The world relies on energy to fuel everything from transportation and communication to national security, housing, food security and health delivery systems. The demand for energy is growing worldwide with it becoming crucial for small island nations such as Maldives. The Republic of Maldives largely depends on imported fuel for meeting its energy needs, thus is highly vulnerable to external shocks. This has evoked the need to measure the energy flows that enter a country and how it is used in different sectors along the year. Since the country experiences sun through the year, energy security can be ensured through reliable, affordable and sustainable solutions (Maldives national energy policy and strategy, Ministry of housing and environment, 2010).

Total primary energy consumption per capita of Maldives reported to be 396,000 toe (Preparing Outer Islands for Sustainable Energy Development Project, 2011). Out of this, 82% accounts to total diesel consumption of the country wherein, final energy consumption is based on demand of various sectors and uses. Major sectors include electricity and transportation (Maldives energy supply and demand survey: 2010-2012, Maldives Energy Authority, 2012). In Maldives, transport sector accounts for one fourth of the total primary energy consumption (98,662 toe) which can be classified on the basis of land or fuel type. Fuel type can be distributed as diesel, petrol, kerosene, Jet A1 and LPG. Diesel and petrol are majorly used for power generation and transportation (Maldives energy supply and demand survey: 2010-2012, Maldives Energy Authority, 2012). Conversion from diesel energy to electricity is the most significant energy conversion in the Maldives. Land is majorly divided into two regions, Greater Male regions and other atolls. According to the availability of uninhabited land in Maldives, this report summarizes land scoping for sandy islands and their fuel potential from microalgae so as to understand the feasibility of constructing photobioreactor for in house biofuel production providing a sustainable solution for energy security.

Total available area after land scoping = $31,822,52 \text{ m}^2 = 3.1 \times 10^6 \text{ m}^2$

Biomass obtained from algae (approximate assumption) = $35 \text{ g/m}^2/\text{day}$

Biomass which can be obtained as per the area after land scoping = $111.4 \times 10^6 \text{ g/day}$

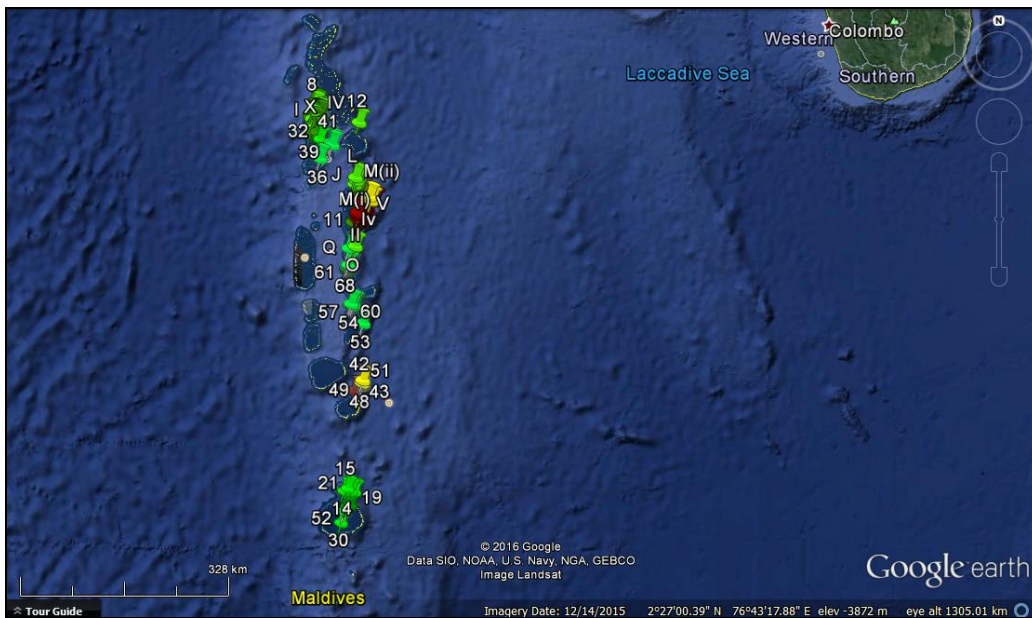
Assuming 25% of oil obtained from biomass = 27.8×10^6 g/day = 27.8 tons/day = 9,188 tons/year

Oil efficiency for meeting total energy consumption for transport sector = 9.3%

Table 1: Area and location of landmarks

Island marker name	m	m	area (m ²)	Latitude	Longitude	acres
L	364	114	41496	4°46'20.73"N	73°27'50.03"E	10.253869
M(i)	1067	100	106700	4°43'59.02"N	73°29'36.59"E	26.366104
M(ii)	3160	100	316000	4°43'44.97"N	73°28'37.46"E	78.08518
Q	200	51.18	10236	3°50'25.87"N	73°22'35.69"E	2.5293668
S	116.88	207.47	24249	5°22'37.62"N	72°57'17.47"E	5.9920723
4	98.51	119.77	11799	5°37'33.19"N	72°56'6.67"E	2.9154789
7	253.67	22.2	5631	5°45'30.90"N	72°56'20.63"E	1.3915654
8	254.33	41.07	10445	5°43'53.30"N	72°55'9.70"E	2.581094
12	265.95	18.45	4907	5°29'57.73"N	73°30'39.61"E	1.2124893
15	143.49	76.46	10971	0°42'22.75"N	73°19'51.00"E	2.7110496
18	96.79	61.94	5995	0°50'46.92"N	73°12'30.20"E	1.4814371
19	148.59	37.76	5611	0°39'46.49"N	73°25'6.52"E	1.3864465
21	156.87	79.5	12471	0°40'10.44"N	73°22'4.59"E	3.0816872
22	212.62	87.6	18626	0°29'11.68"N	73°21'49.67"E	4.6024571
23	127.49	67.37	8589	0°27'53.96"N	73°18'52.09"E	2.1223852
30	193.79	57.44	11131	0°15'2.05"N	73°14'3.21"E	2.7505993
32	140.28	26.56	3726	5°17'51.82"N	72°59'37.88"E	0.9206729
36	191.81	17.68	3391	5° 1'45.77"N	72°59'28.34"E	0.8379827
39	142.72	109.22	15588	5°12'23.89"N	73° 9'15.20"E	3.8518427
41	287.18	103.2	29637	5°14'6.53"N	73° 8'21.88"E	7.323445
42	192	120	23040	2° 2'45.27"N	73°31'56.80"E	5.6932992
43	224	116	25984	2° 3'24.55"N	73°32'4.88"E	6.4207763
44	192.7	51	9828	2° 3'31.60"N	73°32'5.53"E	2.4284738
45	160	138	22080	2° 3'41.62"N	73°32'5.61"E	5.4560784
46	354	163	57702	2° 3'58.18"N	73°32'5.14"E	14.258453
47	968	130	125840	2° 4'25.91"N	73°32'7.11"E	31.095693
48	149	127	18923	2° 4'39.09"N	73°32'24.07"E	4.6759679
49	739	200	147800	2° 4'50.43"N	73°32'19.63"E	36.522119
51	549	87	47763	2° 6'51.45"N	73°32'41.76"E	11.802476
52	330.36	216	71358	0°23'17.75"N	73°16'35.37"E	17.632859
14	160	32	5120	0°40'17.63"N	73°16'59.14"E	1.2651776
53	310	224	69440	2°51'34.12"N	73°33'24.72"E	17.158971
54	692	150	103800	3° 6'47.96"N	73°24'2.47"E	25.649499

55	460.37	187.38	86264	3° 5'23.81"N	73°23'45.21"E	21.316298
56	553	198	109494	3° 5'35.43"N	73°23'13.90"E	27.056515
57	511	233	119063	3° 6'4.74"N	73°24'31.13"E	29.421063
58	220	83	18260	3° 5'17.15"N	73°25'21.35"E	4.5121373
59	337	210	70770	3° 4'6.18"N	73°27'4.91"E	17.487621
60	279	102	28458	3° 6'23.60"N	73°25'46.73"E	7.0321141
61	1029	213	219177	3°37'18.43"N	73°21'58.77"E	54.159733
62	839	102	85578	3°37'13.67"N	73°22'22.76"E	21.146752
63	282	165	46530	3°36'55.00"N	73°22'36.29"E	11.497796
64	639	140	89460	3°36'54.51"N	73°21'58.69"E	22.106013
65	177	151	26727	3°36'43.25"N	73°22'26.18"E	6.6043753
66	507	116	58812	3°36'28.26"N	73°22'20.76"E	14.532739
67	653	230	150190	3°36'14.07"N	73°22'49.15"E	37.1127
68	507	263	133341	3°35'53.76"N	73°21'51.85"E	32.949228
69	257	261	67077	3°34'51.62"N	73°21'3.08"E	16.575062
70	328	158	51824	3°34'21.42"N	73°20'54.59"E	12.80597
71	406	323	131138	3°34'0.88"N	73°20'43.16"E	32.404855
72	325.13	508.2	165231	3°32'31.36"N	73°20'59.28"E	40.829423
73	352	327.2	115174	3°32'53.23"N	73°21'17.85"E	28.46017
5	126.4	62.1	7849	5°36'7.19"N	72°54'51.65"E	1.9396359
6	115.86	55.25	6401	5°36'28.86"N	72°59'22.57"E	1.5817846
10	276.66	34.54	9556	5°46'0.34"N	72°53'36.35"E	2.361295
		Total	3182252			786.35035



Picture 1: Geospatial view of Maldives with potential landmarks for algal cultivation



Picture 2: A group of island in south Maldives. The area and Latitude- Longitude of depicted landmarks is listed in the Table 1.

Table 1: Area and latitude- Longitude of landmarks listed in picture 2.

Landmarks	Latitude-Longitude	Area (square meter)
42	2° 2'45.27"N 73°31'56.80"E	23,040
43	2° 3'24.55"N 73°32'4.88"E	25,984
44	2° 3'31.60"N 73°32'5.53"E	9,828
45	2° 3'41.62"N 73°32'5.61"E	22,080
46	2° 3'58.18"N 73°32'5.14"E	57,702
47	2° 4'25.91"N 73°32'7.11"E	125,840
48	2° 4'39.09"N 73°32'24.07"E	18,923
49	2° 4'50.43"N 73°32'19.63"E	147,800





Picture 3: Landmark is located in south Maldives

Latitude-Longitude: 2° 6'51.45"N- 73°32'41.76"E

Area: 47,763 square meter

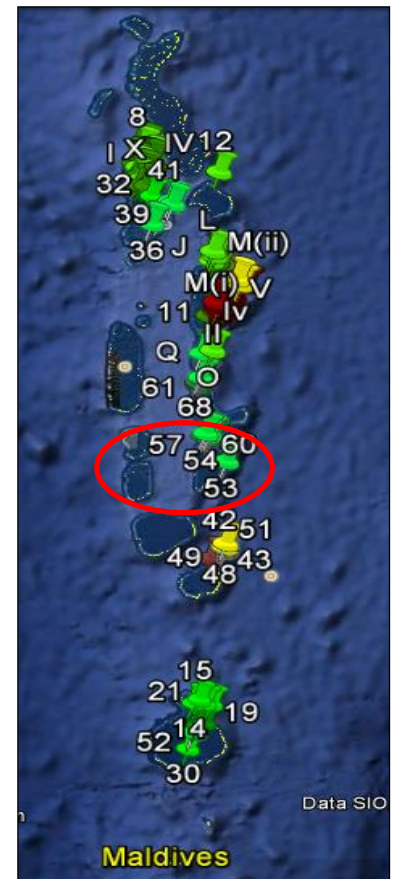




Picture 4: Landmark is located in south Maldives. The area and Latitude- Longitude of depicted landmarks is listed in the Table 2.

Table 2: Area and latitude- Longitude of landmarks listed in picture 4.

Landmarks	Latitude-Longitude	Area (square meter)
54	3° 6'47.96"N 73°24'2.47"E	1,03,800
55	3° 5'23.81"N 73°23'45.21"E	86,264
56	3° 5'35.43"N 73°23'13.90"E	1,09,494
57	3° 6'4.74"N 73°24'31.13"E	1,19,063
58	3° 5'17.15"N 73°25'21.35"E	18,260
60	3° 6'23.60"N 73°25'46.73"E	28,458

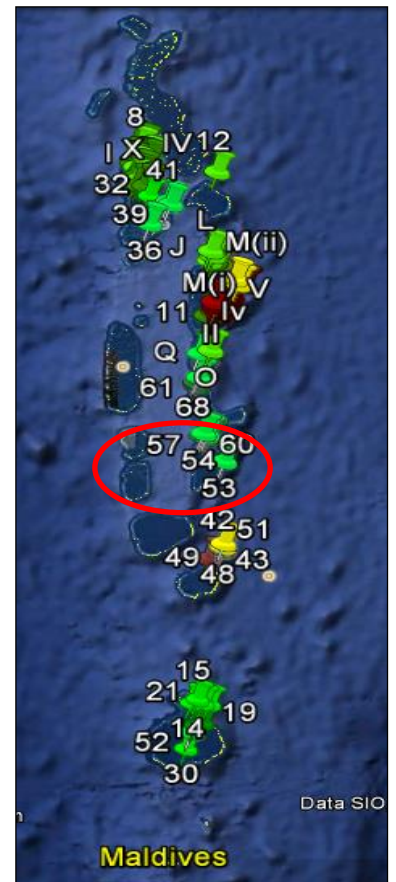




Picture 5: Landmark is located in south Maldives

Latitude-Longitude: 3° 4'6.18"N- 73°27'4.91"E

Area: 70,770 square meter



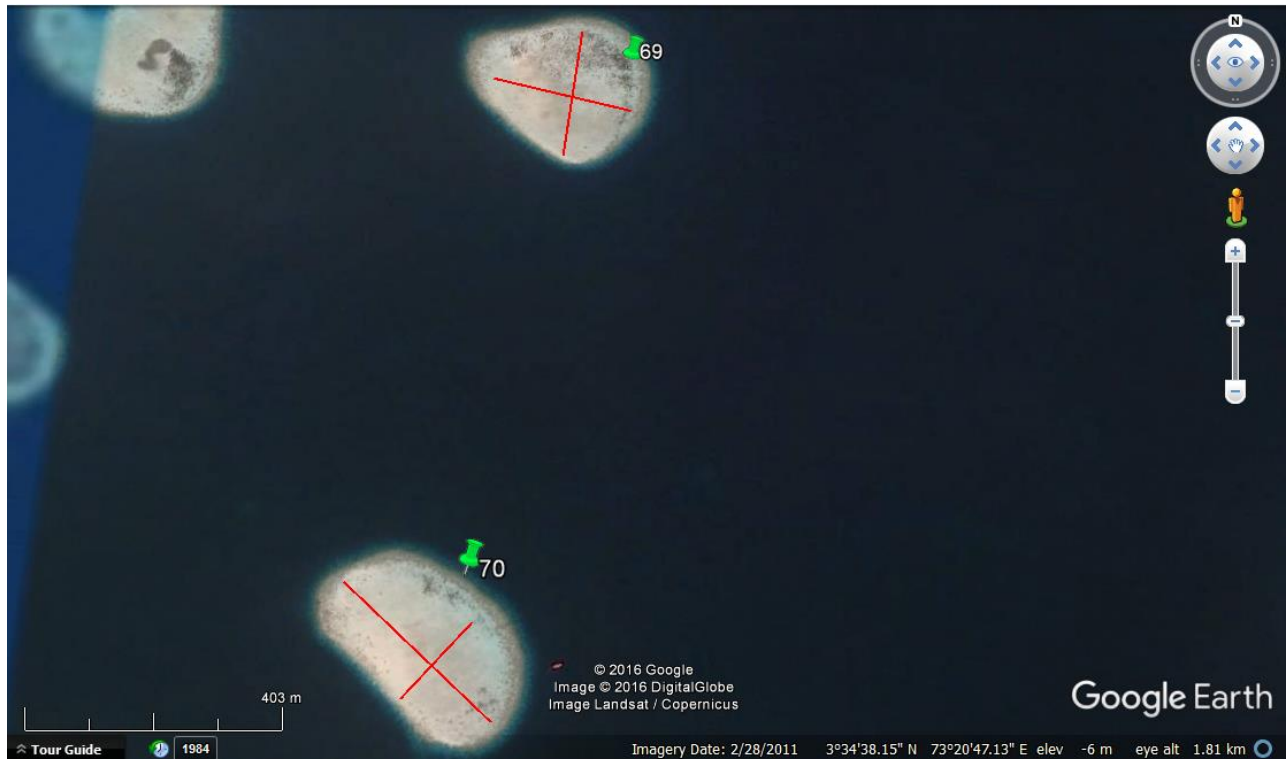


Picture 6: Landmark is located in south Maldives. The area and Latitude-Longitude of depicted landmarks is listed in the Table 3.

Table 3: Area and latitude- Longitude of landmarks listed in picture 6.

Landmarks	Latitude-Longitude	Area (square meter)
61	3°37'18.43"N 73°21'58.77"E	219,177
62	3°37'13.67"N 73°22'22.76"E	85,578
63	3°36'55.00"N 73°22'36.29"E	46,530
64	3°36'54.51"N 73°21'58.69"E	89,460
65	3°36'43.25"N 73°22'26.18"E	26,727
66	3°36'28.26"N 73°22'20.76"E	58,812
67	3°36'14.07"N 73°22'49.15"E	150,190
68	3°35'53.76"N 73°21'51.85"E	133,341





Picture 7: Landmark is located in an atoll in the south of Maldives. The area and Latitude- Longitude of depicted landmarks is listed in the Table 4

Table 4: Area and latitude- Longitude of landmarks listed in picture 7.

Landmarks	Latitude-Longitude	Area (square meter)
69	3°34'51.62"N 73°21'3.08"E	67,077
70	3°34'21.42"N 73°20'54.59"E	51,824





Picture 8: Landmark is located in an atoll in the south of Maldives

Latitude-Longitude: 3°34'0.88"N 73°20'43.16"E

Area: 1,31,138 square meter





Picture 9: Landmark is located in an atoll in the south of Maldives. The area and Latitude- Longitude of depicted landmarks is listed in the Table 5

Table 5: Area and latitude- Longitude of landmarks listed in picture 9.

Landmarks	Latitude-Longitude	Area (square meter)
72	3°32'31.36"N 73°20'59.28"E	165,231
73	3°32'53.23"N 73°21'17.85"E	115,174

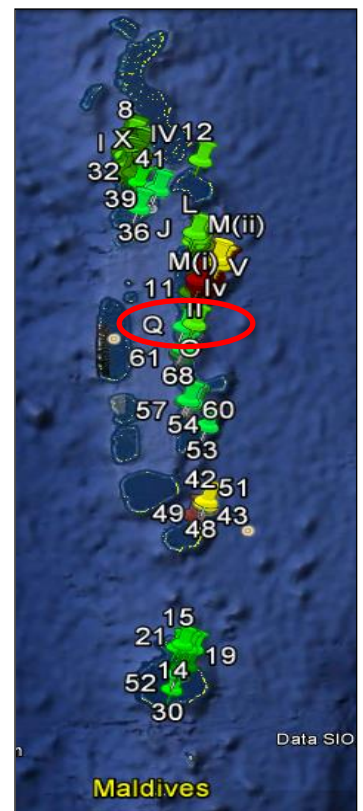




Picture 10: Landmark is located in an atoll in the middle of Maldives

Latitude-Longitude: 3°50'25.87"N- 73°22'35.69"E

Area: 10,236 square meter





Picture 11: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 5°22'37.62"N- 72°57'17.47"E

Area: 24249 square meter

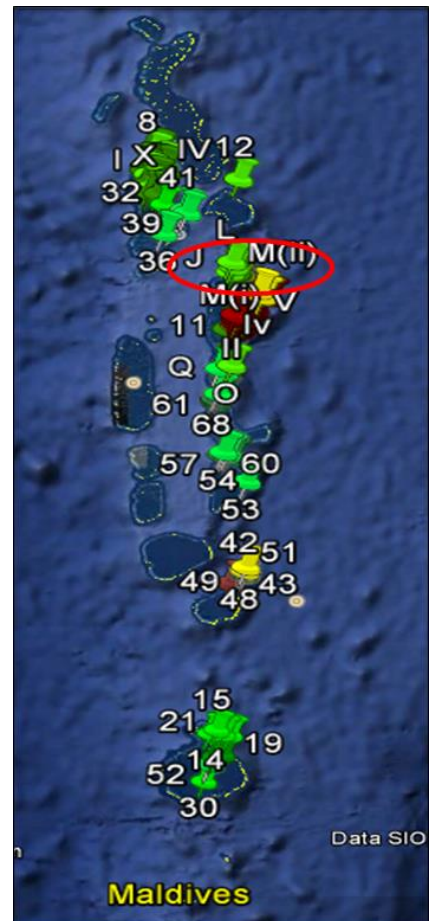


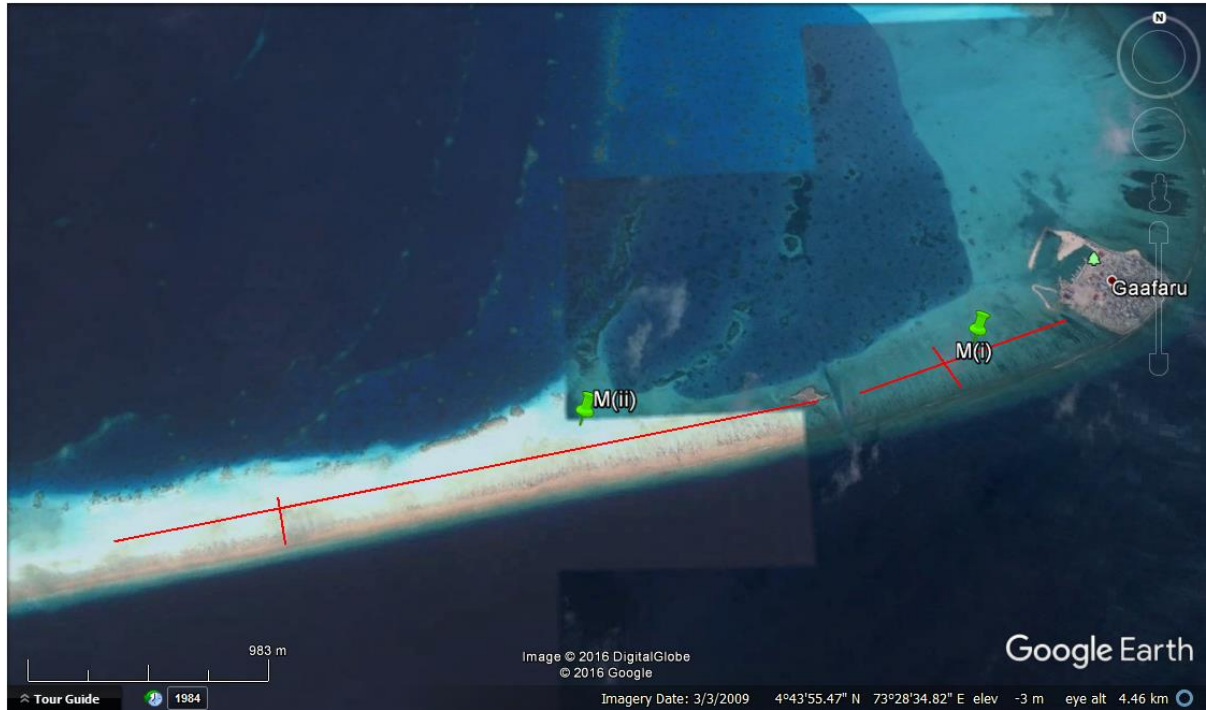


Picture 11: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 4°46'20.73"N- 73°27'50.03"E

Area: 41496 square meter

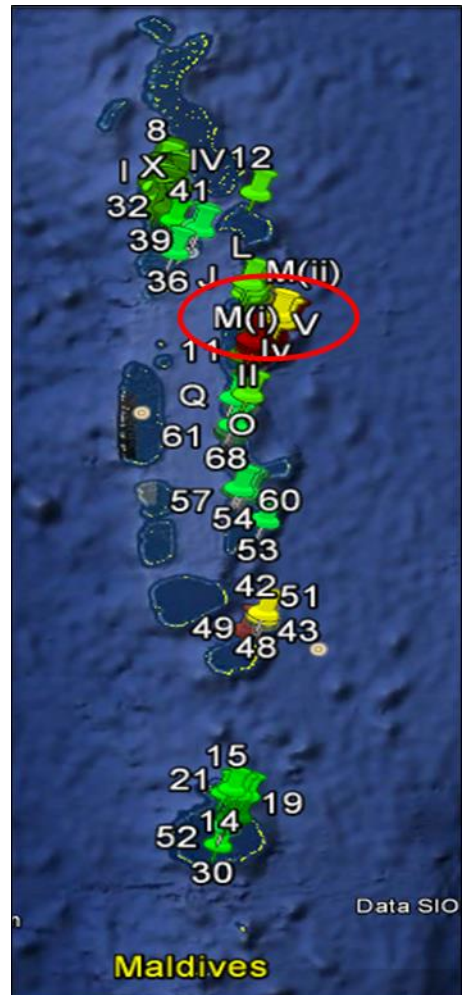




Picture 12: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 4°43'44.97"N- 73°28'37.46"E

Area: 316,000 square meter





Picture 13: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 5°37'33.19"N- 72°56'6.67"E

Area: 11799 square meter





Picture 14: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 5°12'23.89"N- 73° 9'15.20"E

Area: 15588 square meter



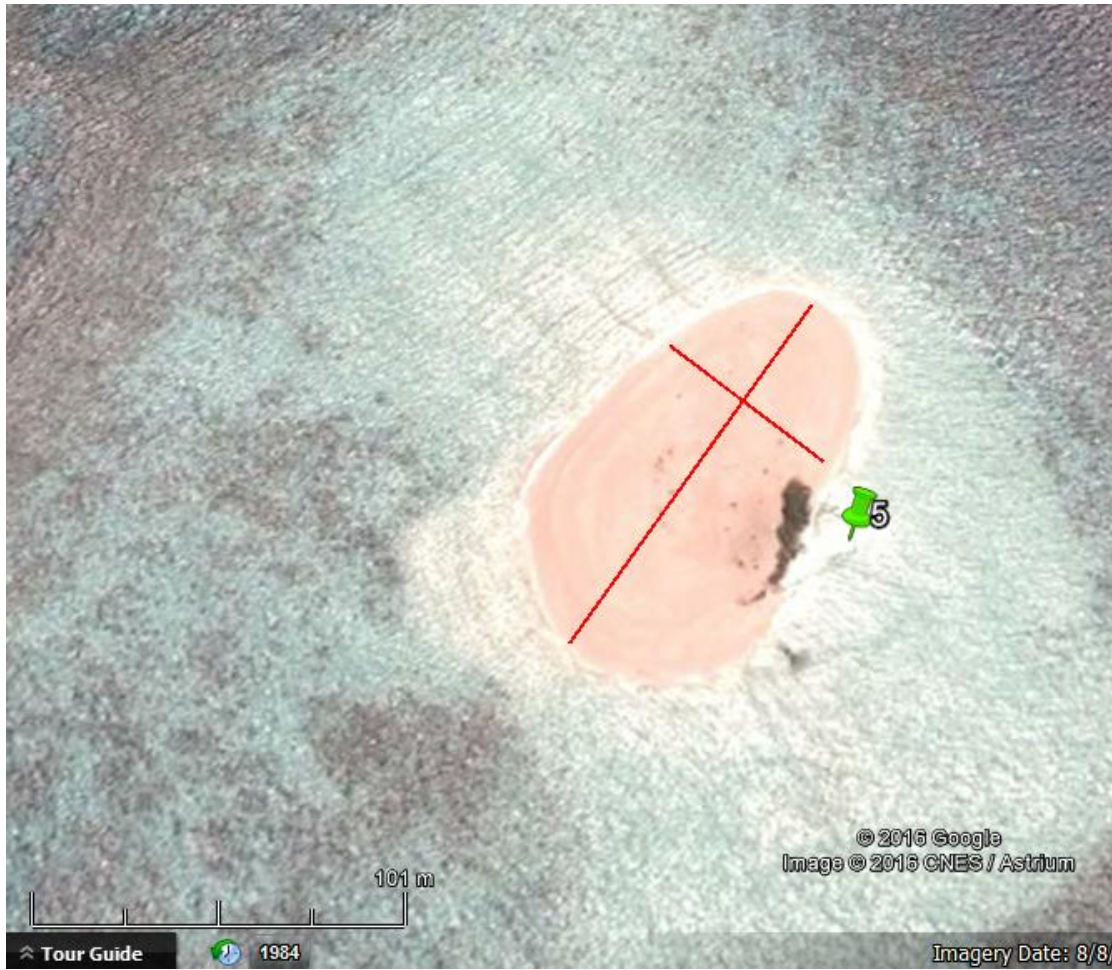


Picture 15: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 5°17'51.82"N- 72°59'37.88"E

Area: 3726 square meter





Picture 16: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 5°36'7.19"N- 72°54'51.65"E

Area: 7849 square meter





Picture 17: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 5°36'28.86"N- 72°59'22.57"E

Area: 6401 square meter





Picture 18: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 5°46'0.34"N- 72°53'36.35"E

Area: 9556 square meter





Picture 19: Landmark is located in an atoll in North Maldives

Latitude-Longitude: 5°29'57.73"N- 73°30'39.61"E

Area: 4907 square meter

