

# Smart Pavement Inspection



Co., Ltd.

25th Feb. 2021

[www.bumprecorder.com](http://www.bumprecorder.com)

[info@bumprecorder.com](mailto:info@bumprecorder.com)

# Company Profile



Co., Ltd.

Start up : Oct. 23<sup>rd</sup> 2013 (7 years)

Funder & CEO : YAGI, Koichi

Office : Akabane, Tokyo, Japan

## Main service

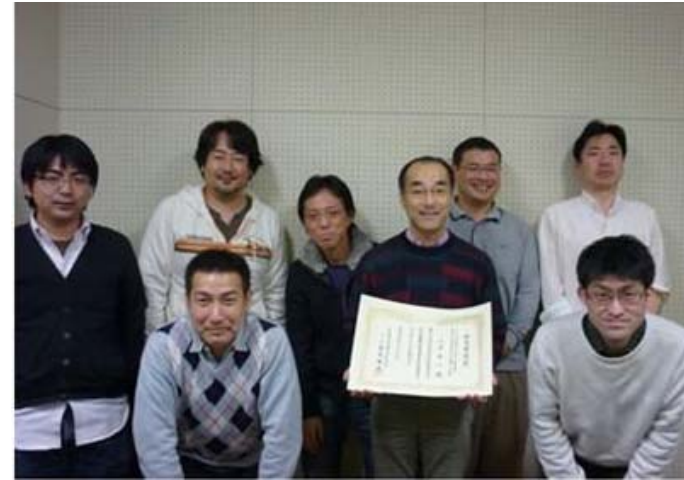
- : Pavement inspection application  
It was developed since 2007. (13 years)
- Photo report : Human visual inspection supporting tool

# Won many awards!

Android Application Award 2011



JSTE Research Award 2011



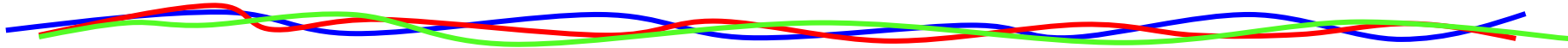
Japan e-Land Map Award 2014



Tokyo Venture Technology Award 2015

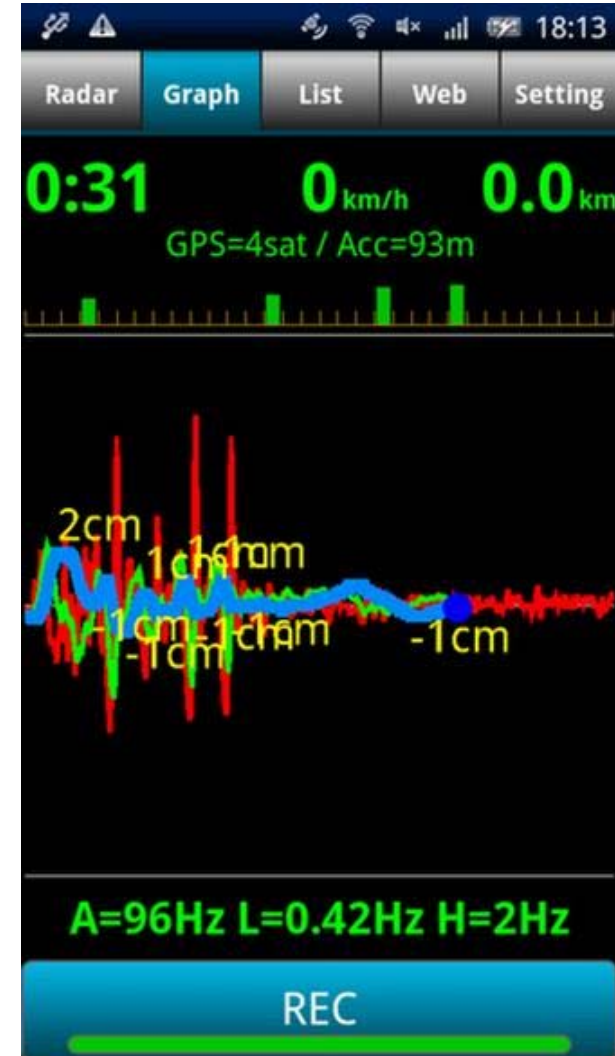


# overview



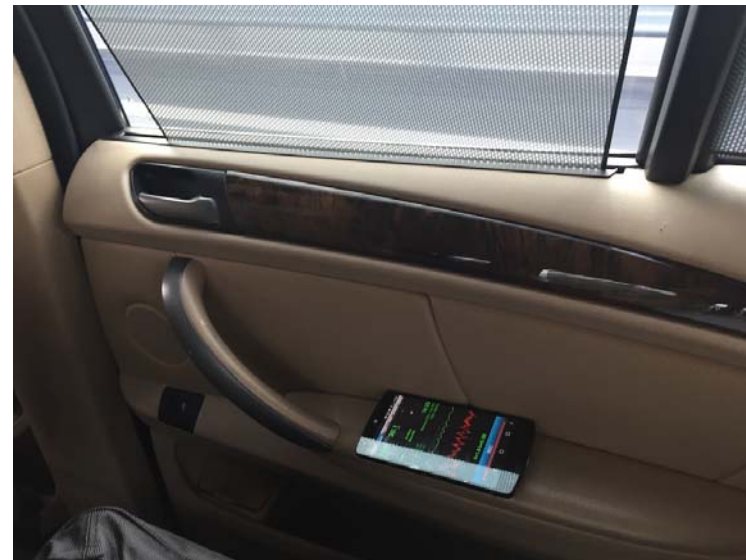
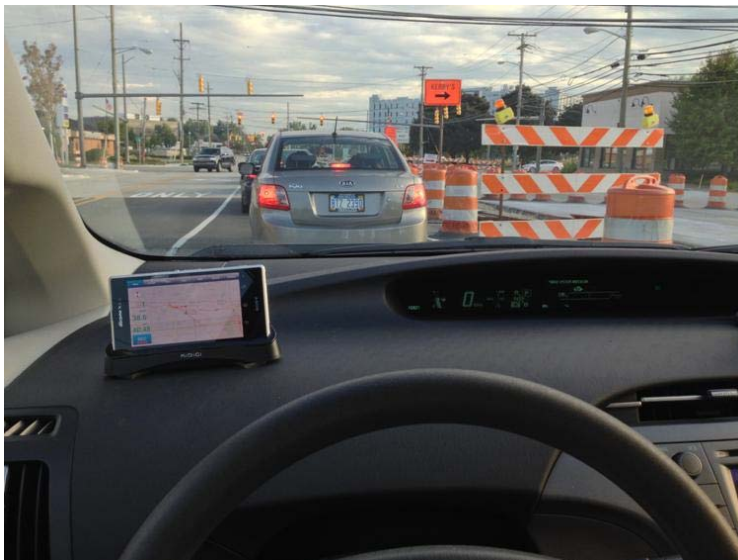
# for data inspection

Vibration data is collected under the driving by Smartphone App.



# Smartphone app

Smartphone is placed on hard surface tightly, like dashboard, arm rest.

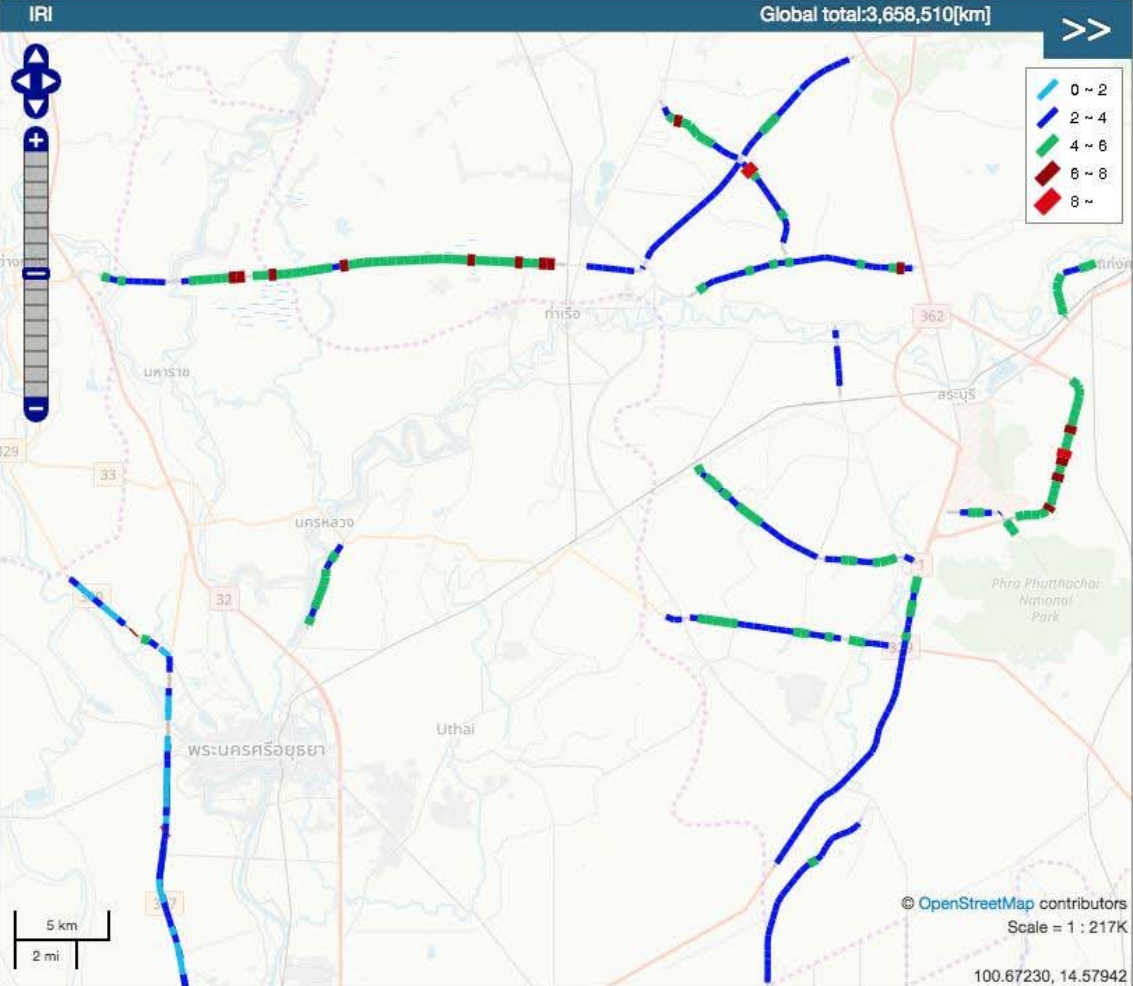


# Web GIS

Result will be shown on web map soon.

BumpRecorder Web for BumpRecorder Data Download PhotoReport Other Free App yagi-san, Hello Logout

IRI Global total:3,658,510[km] >>



Background map OpenStreetMap  Pale Pro Version x

Search condition  
 from 2011-03-01 to 2019-03-15 Compare  
 Measured by  Shared  My group  My self Search

Drawing data type  
 GPS path  Legend Legend Class 2~8  
 Speed >= 20km/h  
 IRI  JRI  Crack  Linearity All Direction  
 MCI  PCR  Speed  LTx  LTz  Ax  Az  
 Bump(2m)  (10m)  (15m)  Bump(Spring)  
 Dashcam Photo

Area selection  Rectangle  Polygon  Line

Position 1 Latitude Longitude  
 Position 2 Latitude Longitude Clear

Analyze Type Histogram at select point Analyze

Data List  
 Search Result Latest Japan Latest Global

Date Time	Distance	Comment	Lat from	Lon from	Country
2018/07/26 09:39:56	3		14.291...	100.42...	Thailand
2018/04/06 16:40:22	18.3		14.441...	100.89...	Thailand
2018/04/06 15:04:58	15.6	2089/100	14.660...	101.19...	Thailand

© OpenStreetMap contributors Scale = 1 : 217K 100.67230, 14.57942

# for data inspection

Measurement result can be shown on the map online.

BumpRecorder Web for BumpRecorder株式会社 計測データ

Global total:606.316[km]

その他 無料アプリ yagi さん、こんにちは ログアウト

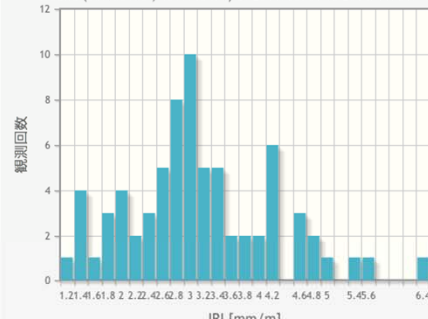
背景地図 GSI Maps Light-colored

検索条件  
 from 2011-03-01 to 2014-11-01 検索  
 計測者 自分 自グループ みんな GLC社

表示種類  
経路 凡例 凡例区分 2.4~15  
段差高 IRI 平坦性 走行方向:全方向

地図クリック地点  
 地点1 35.650968 139.913476 段差情報表示  
 地点2 35.649399 139.91162 Clear L=241m

解析種類 選択地点のヒストグラム 解析

グラフ  
 around (35.650968, 139.913476) at 2011/03/01 to 2014/11/01.  
  
 1.21 4.1 6.1 8.2 2.22 4.2 6.2 8.3 3.23 4.3 6.3 8.4 4.4 4.6 4.8 5 5.45 6 6.4

データリスト  
 検索結果 みんなの最新 GLC社の最新 世界の最新

日時	距離	コメント	起点緯度	起点経度	起点市区町村
2014/07/29 01:11:25	78.2	成田→羽田	35.783...	140.35...	千葉県成田市
2014/07/27 23:42:38	35	トレーラー	35.688...	139.97...	千葉県船橋市
2014/07/11 06:37:29	66.7		35.619...	140.08...	千葉県千葉市
2014/07/10 05:08:59	332.1		35.875...	139.51...	埼玉県ふじみ市
2014/05/25 21:01:45	42.6		35.643...	139.89...	千葉県浦安市
2014/05/25 20:33:36	22.1		35.627...	140.08...	千葉県千葉市
2014/05/25 15:38:23	46.7		35.779...	139.70...	東京都板橋区
2014/05/05 15:42:51	49.7		35.641	139.88	千葉県浦安市



# Our belief

Simple, speedy, low cost

Keep inspection


**BumpRecorder**

Pavement Roughness Measurement  
Smartphone Application

**BumpRecorder**

Pavement Maintenance Management  
Cloud service

**BumpRecorder Web**

Simple · Speedy · Low cost  
Next Generation Maintenance Management Service




Winning Tokyo Venture Technology Award 2015,  
the Special Award 2014

Innovative Smart Pavement Inspection :+81-3-6454-4255 (9AM-5PM JST)


**BumpRecorder Co., Ltd.**    Top   Leaflet   Manual   Technology   News   About us   日本語

## Keep Inspection

### Smartphone based Pavement Management


[View Video](#)

#### Main Services




**IRI Measurement**

[BumpRecorder] It is a service that IRI, Cracking rate can be measured easily, convenient and high quality by simply fixing the smartphone to the car. When you measure the vibration of a running vehicle with a smartphone app and upload it to our server, you can check it on the map of Web analytics service site in about 10 minutes.



**Patrol Daily Report**

[Photo Report] Visual inspection and record of work can be recorded easily with photos of smartphones or GPS. The work record can be output as a daily report. Combined with BumpRecorder, you can patrol and display where you worked in the daily report.



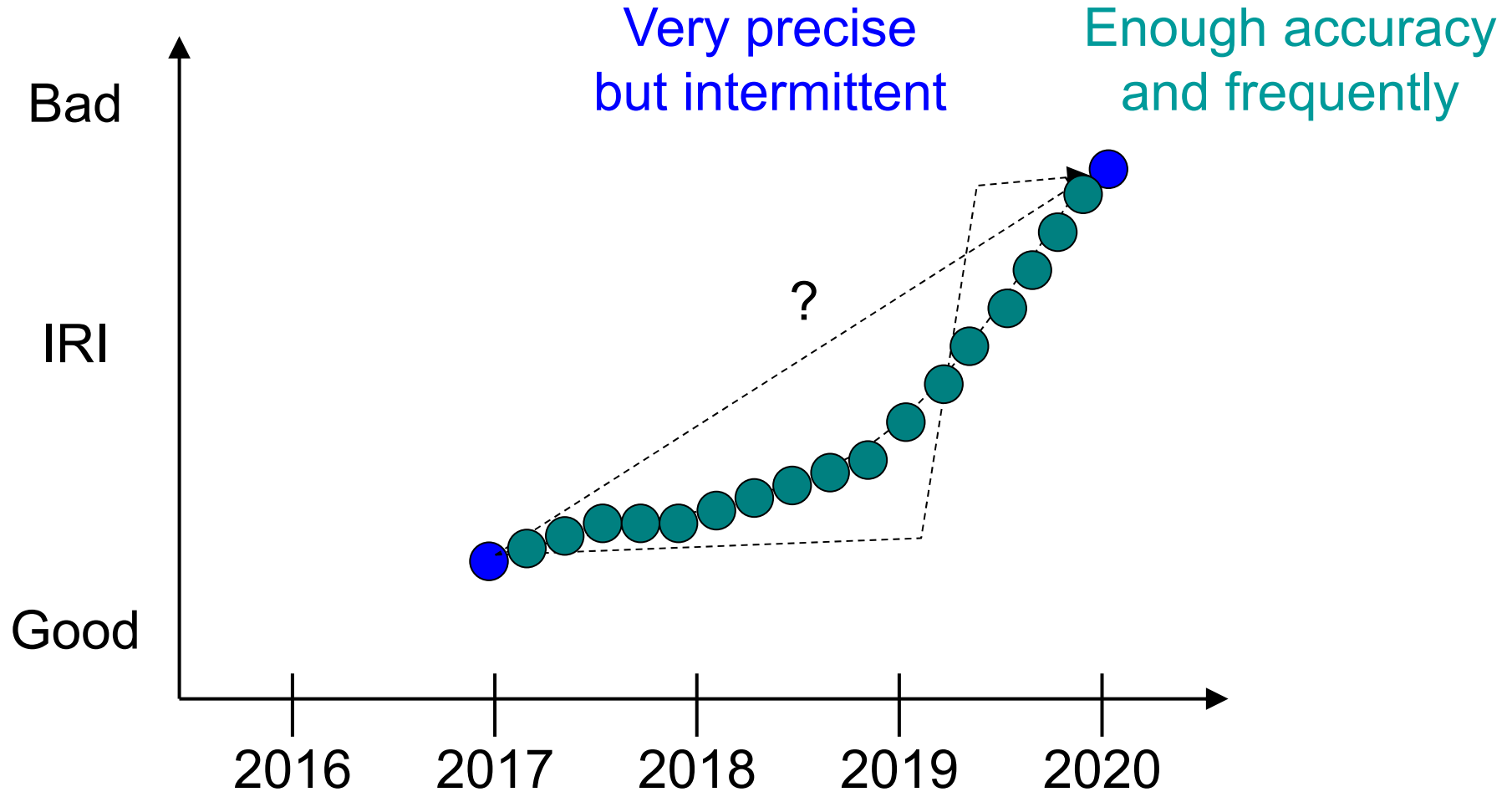
**Sensor/GPS Data Analysis**

We are conducting analysis and consulting of various vibration data and position information as well as road surface properties. Traffic situation based on GPS information, sudden braking analysis, etc. are also possible. Please feel free to contact us.

<https://www.bumprecorder.com/en/>

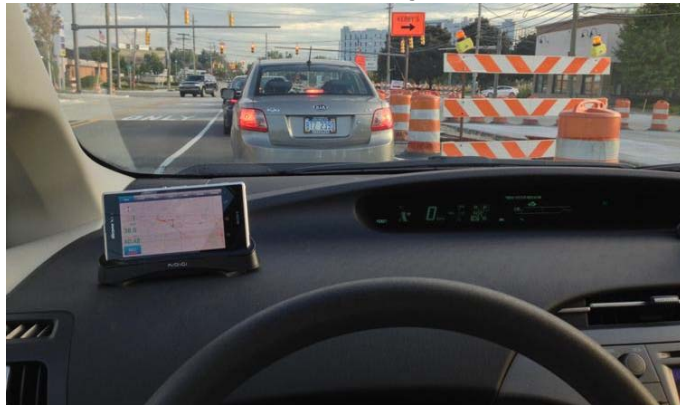
Not require special skill,  
it can use continuously.

# What is right monitoring?



# What is right monitoring?

Pavement health monitoring  
Smartphone type



Low cost

Inertial profiler



Very precise

Human health monitoring  
Body temp, Blood pressure



CT scanner



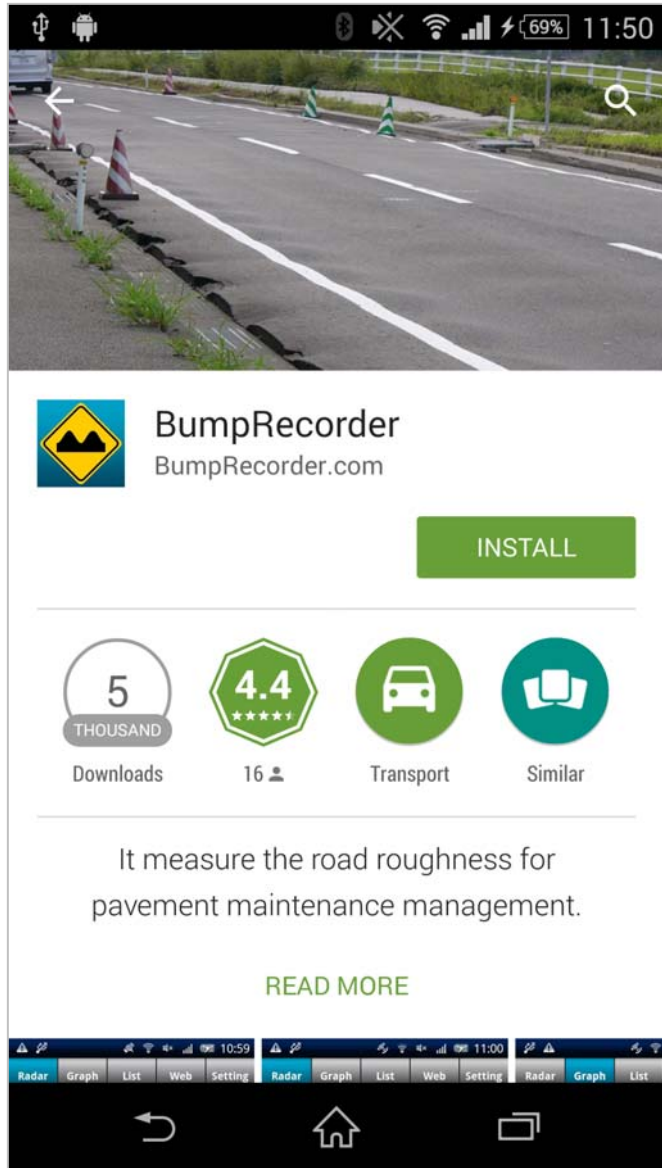
# How to use

# ?



Please visit web page to get manual  
<https://www.bumprecorder.com/>

# Install on your Smartphone



BumpRecorder is installed from Google Play. It can search or Bump Navi.

# Place on the dashboard tightly



Any tilt angle is okay, but must placed tightly NOT recommend



Not only fixed at left and right, but also bottom side.

It use sticky sheet on the bottom side.



It is easy vibrate itself

# Accuracy



# IRI is classified 4 class

Some document explained “response type is class 3”.  
But I said is class 2.

This is the key point  
of our technology!

High accuracy ->

->

Other smartphone app ->

Low accuracy ->

## Classification of Roughness Measuring Devices

World Bank sponsored International Road Roughness Experiments (IRRE) conducted in Brazil in 1982, categorised the related equipments into 4 classes, namely Class I, II, III and IV.

**Class I:** Gives higher standard of accuracy which enable precision measurement of pavement surface profile.

- Rod and Level, TRRL beam, Dipstick, Merlin and Walking Profiler

**Class II:** Profile is measured as the basis of direct computation of international roughness index (IRI), very less accuracy compared to class I measurement.

- APJ Trailer etc.

**Class III:** Response Type Road Roughness Measuring System (RTRRMS)

- Automatic Road Unevenness Recorder / Bump Integrator / Roughometer, Car Axle Mounted Bump Integrator, Mays Meter etc.

**Class IV:** Methods used in situations where higher accuracy is not essential.

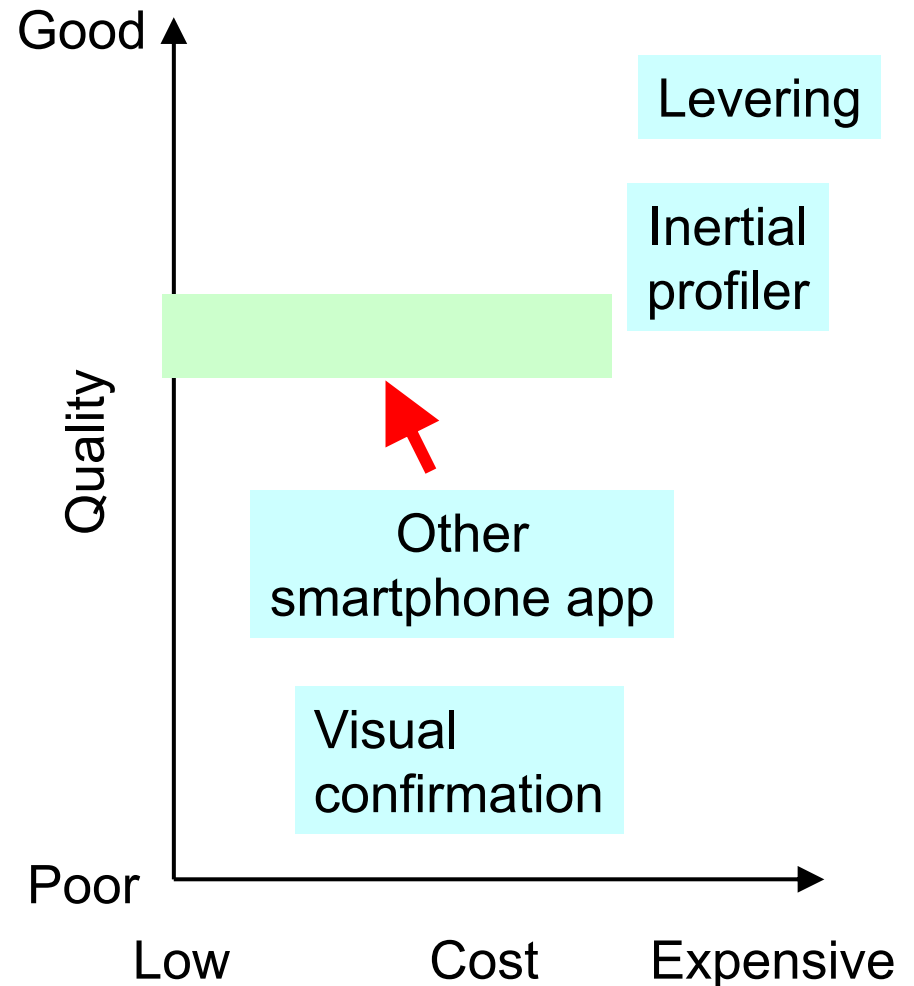
- Ride experience, Visual inspection



# Position of

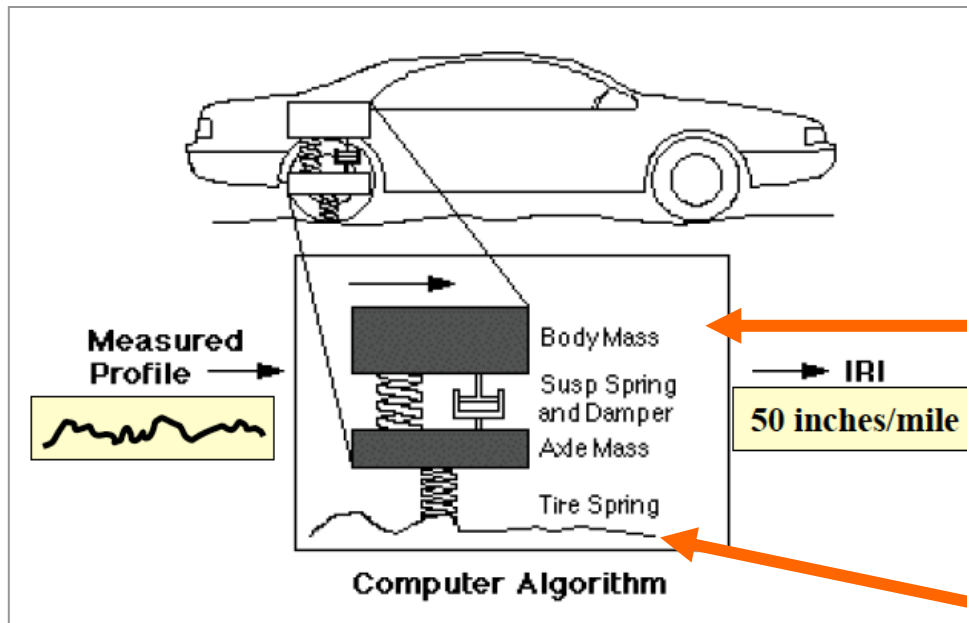
is more precise and lower cost for IRI measurement.

Class 1 Precise Static method	Profilometric QC simulation
Class 2 Other method	
Class 3 Correlation equations	No QC simulation
Class 4 Subjective ratings	No verifiable



# IRI computation

IRI is suspension movement average under **80km/h**.  
 - average of suspension expansion and compression-

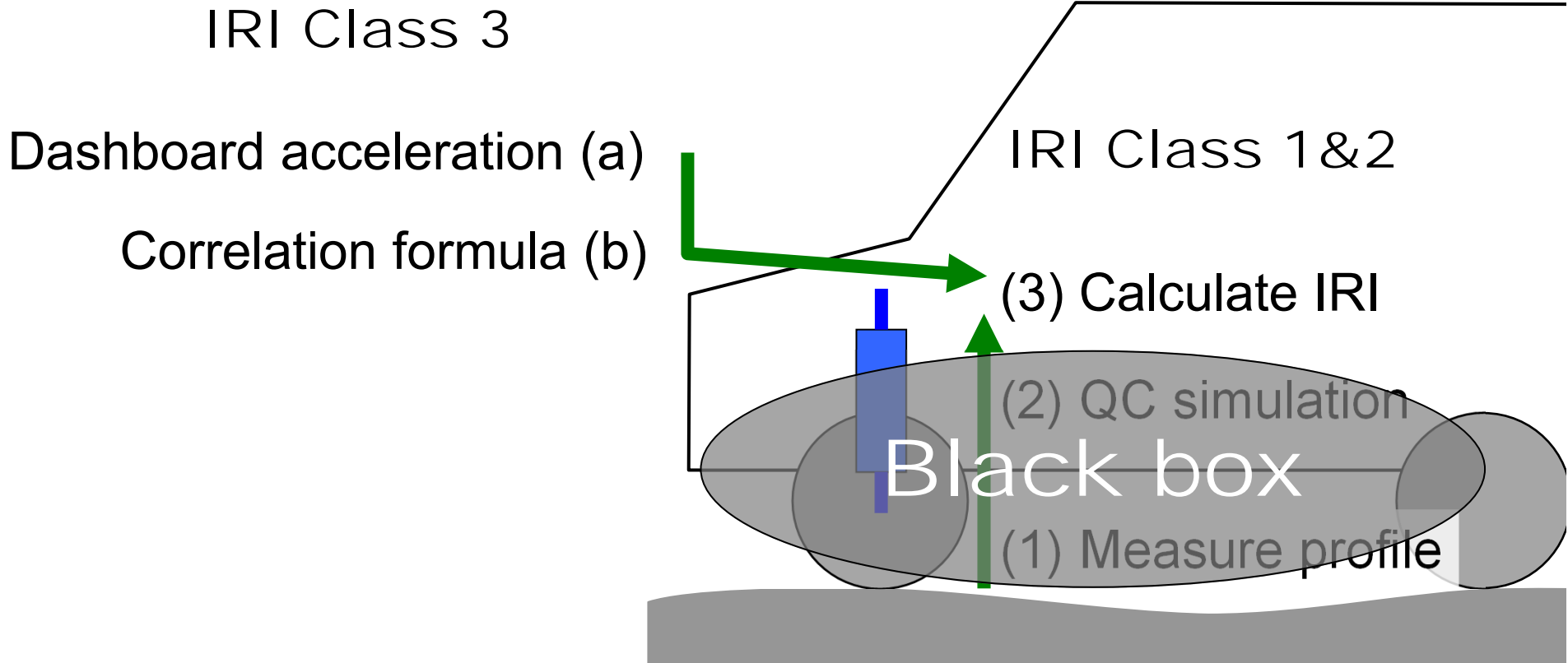


(3) Calculate average length of suspension expansion and contraction, that is IRI.

(2) **QC simulation** is applied to calculate suspension movement.

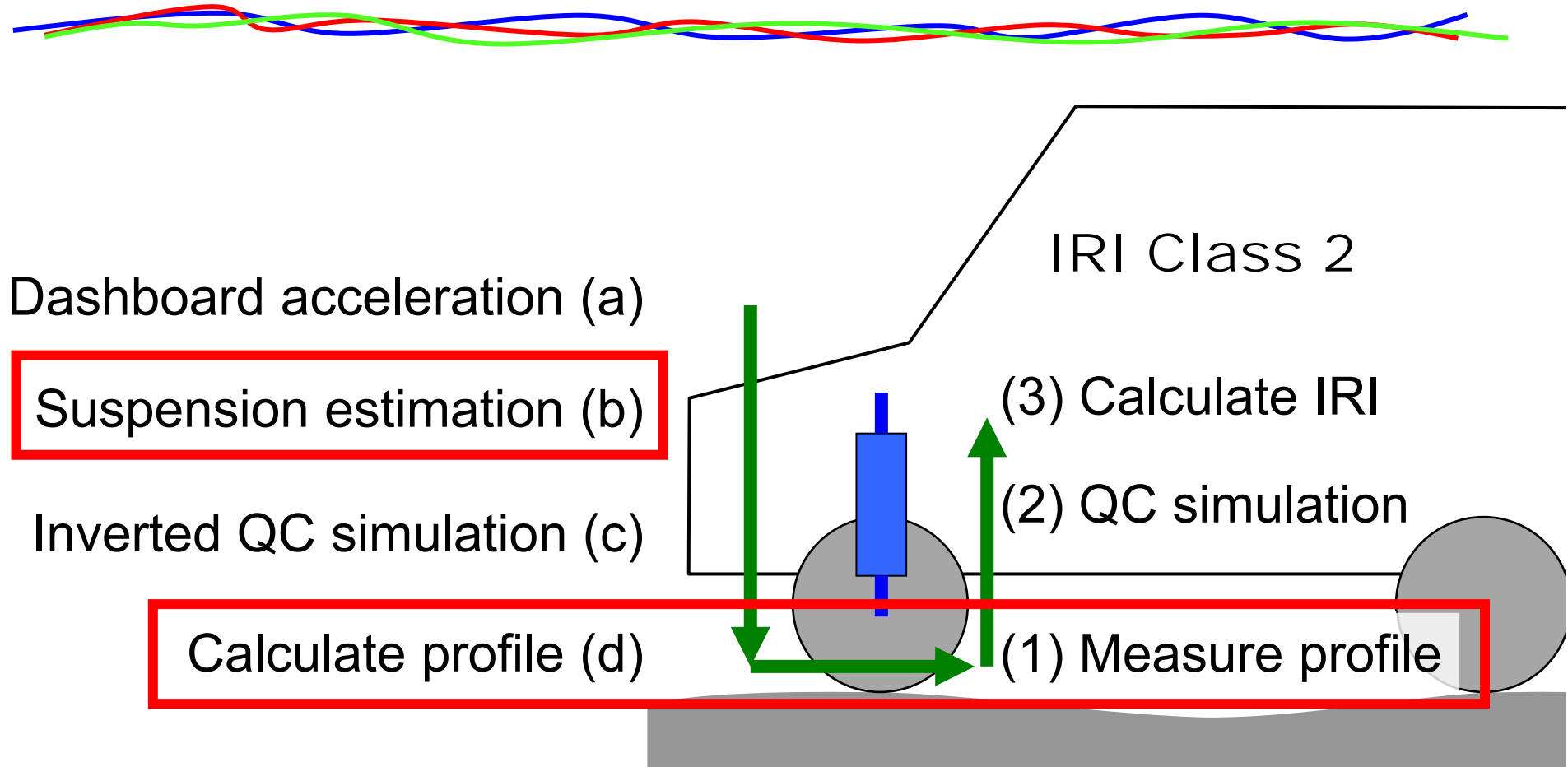
(1) Measuring **longitudinal profile**.

# Other response type is IRI Class 3



Calibration driving is needed.  
Low repeatability.

# is IRI Class 2



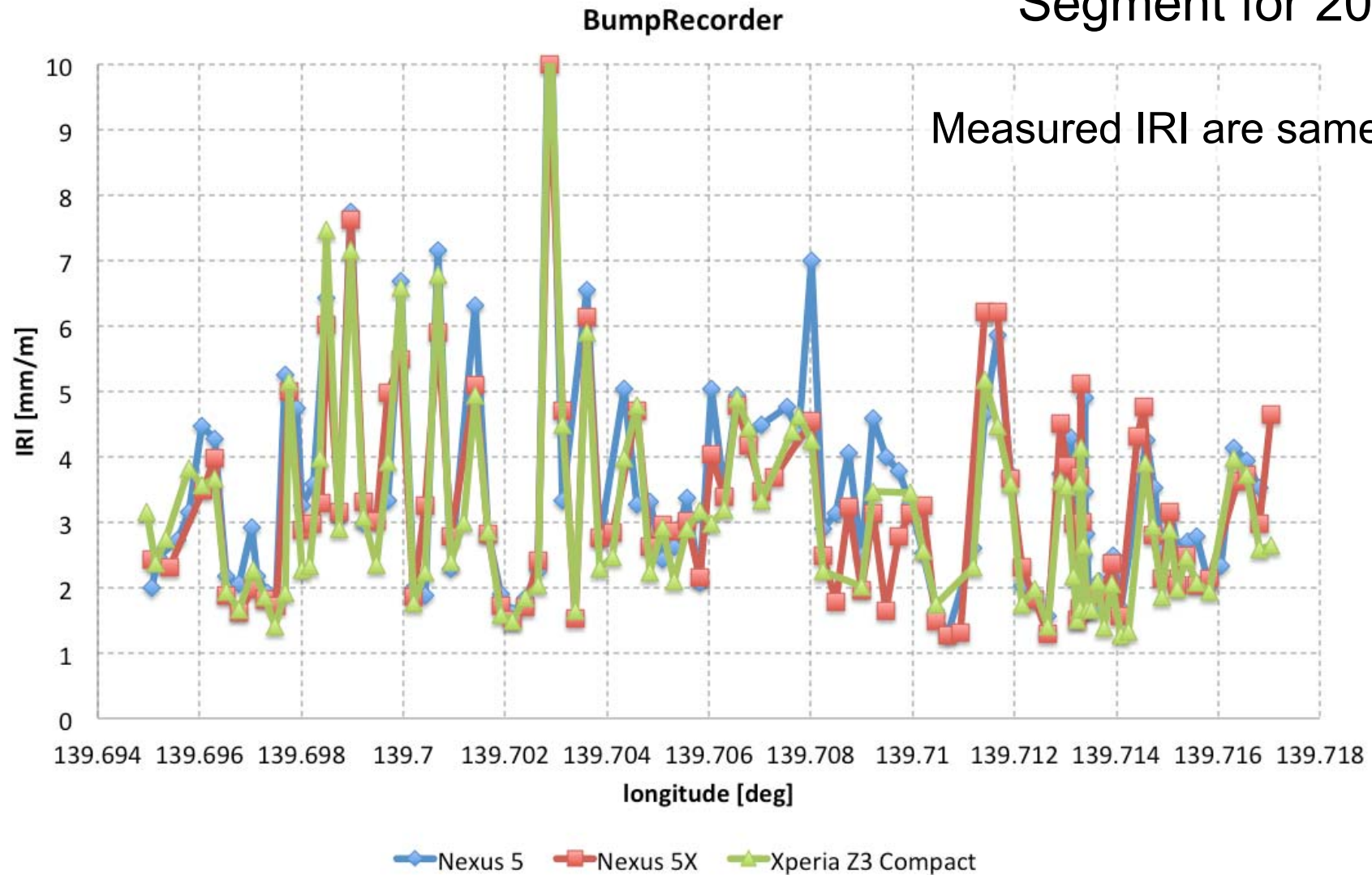
Auto calibration is done during measurement driving.  
Good repeatability.

# Verification Result Reliability



# Using different smartphone model

Segment for 20m

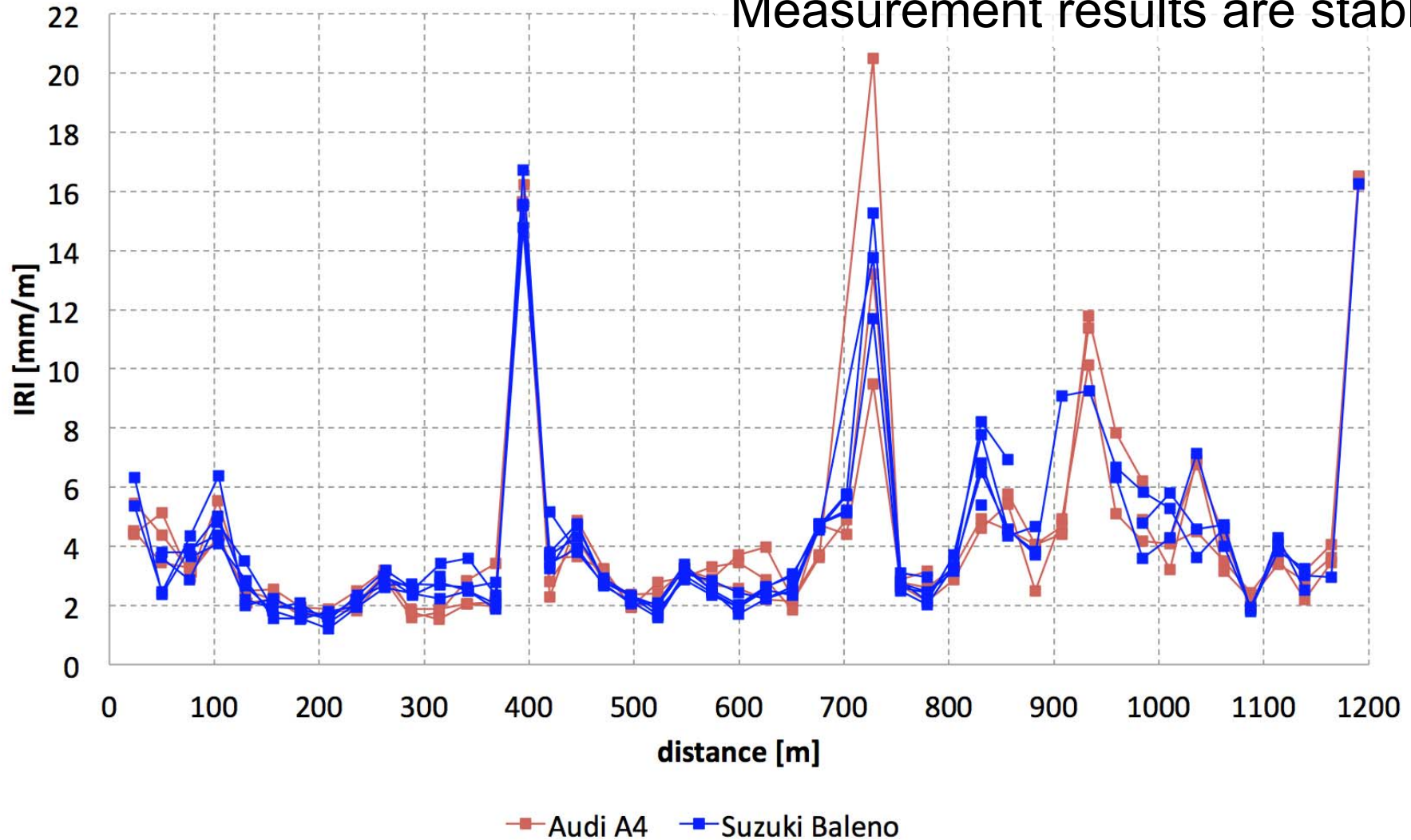


# Using different vehicle type

It measured 3 times

車種依存確認

Measurement results are stable



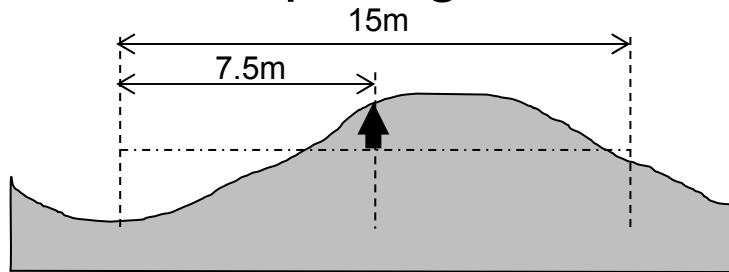
# Comparison with KUMATAKA MRP-3000



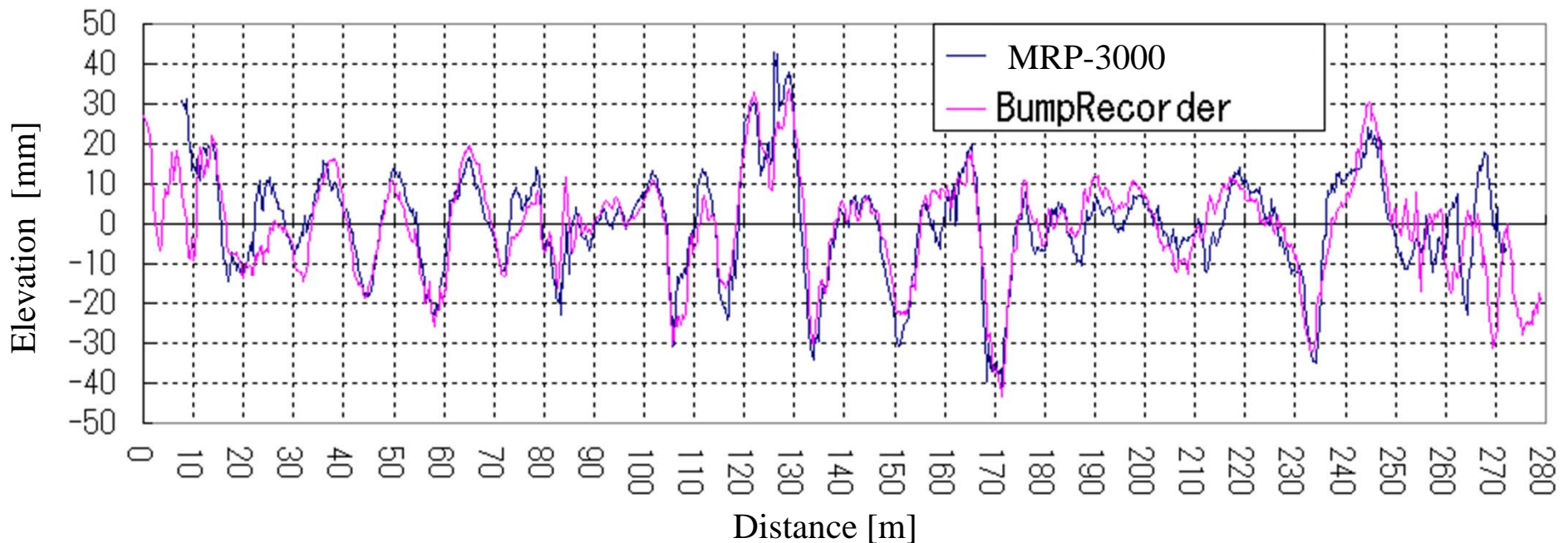


# Comparison : Relative height in 15[m] long

Calculating relative height in 15[m] long for MRP-3000 and BumpRecorder. Then comparing this two values.



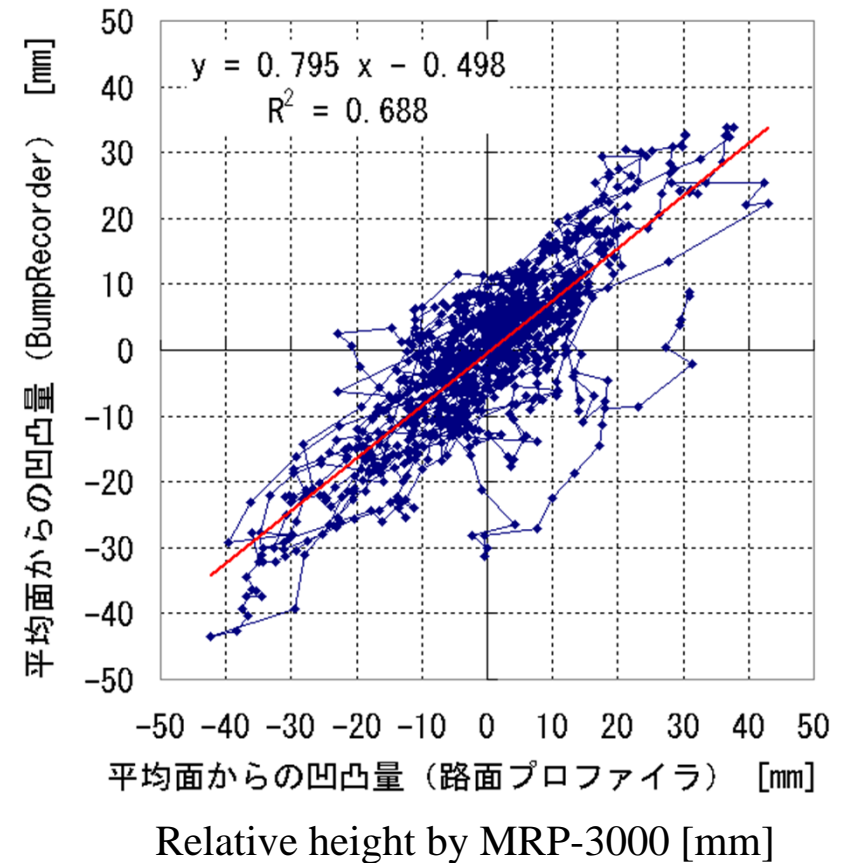
Trend was consistent.  
Position gap was not so large.



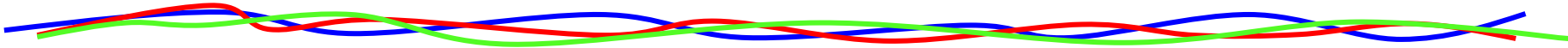
# Comparison : Relative height in 15[m] long

Liner regression was done,  
by using result of MRP-3000  
and BumpRecorder

- Contribution Ratio : 0.688  
= **Correlation coefficient : 0.829**



# Available indexes



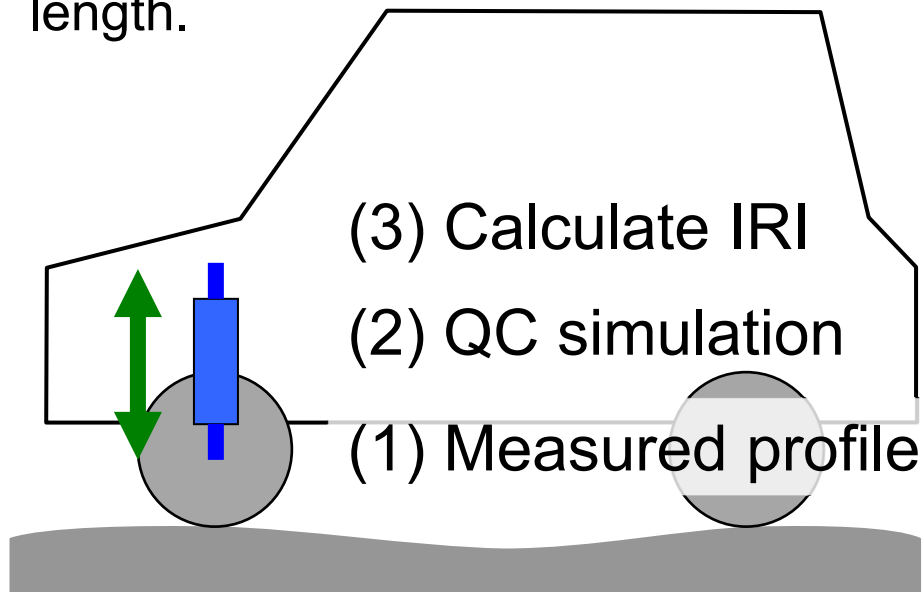
# evaluate indexes

	Road standard				Railway standard
	Global	Japan	India	Original	
Roughness	IRI	JRI	<i>BI</i>		
	Boeing Bump Index				longitudinal level irregularity *
Crack	Surface cracking ratio *			Wheel path cracking ratio	
Rut *	Rut depth *				
Combination	PCR	<i>PSI</i>	MCI		<i>Repair priority</i>
Ride comfort vertical & transverse					Maximum acceleration
					LT index (ISO 2631-4)

supported
  future plan
  N/A
 \* : not support

# Roughness

IRI - International Roughness Index  
 Average of suspension expansion & compression under 80km/h driving situation. It includes longer wave length.

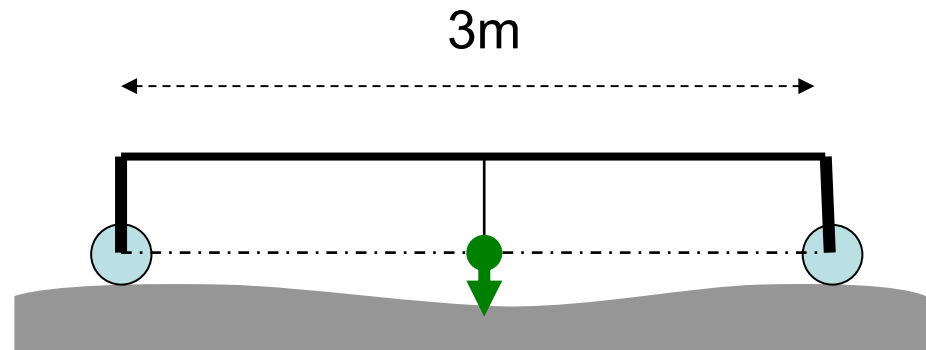


BI - Bump Index

BI converted from IRI by correlation formula.

$$BI = 630 \times (IRI^{1.12})$$

JRI - Japanese Roughness Index  
 Standard deviation of 3m  
 profilometer measurement value. It  
 indicate shorter wave length situation.



Similar to PI : Profile Index

# Boeing Bump Index

IRI / JRI - Roughness

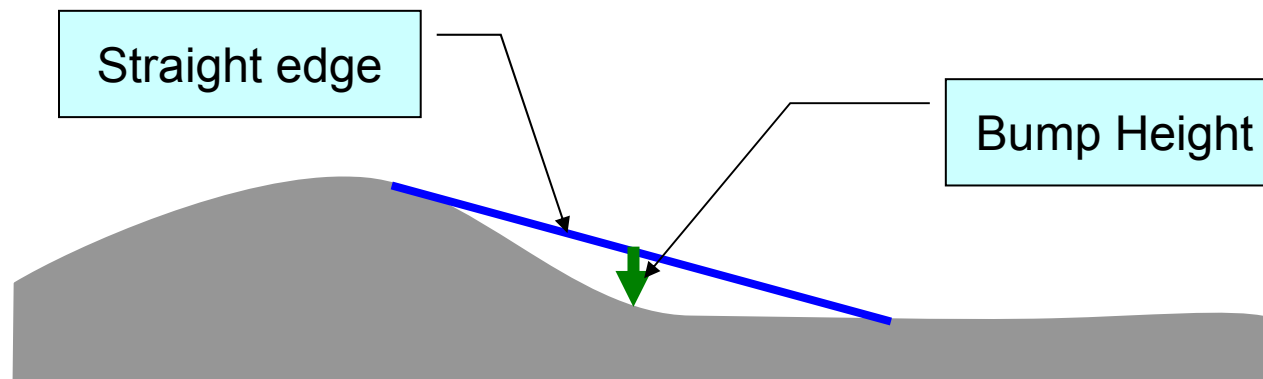
Representative value on the **segment**.

BBI - Boeing Bump Index

**Point** information of the bump size and location.

2m/10m/15m straight edge is used,

and deepest depth is defined Bump Height.

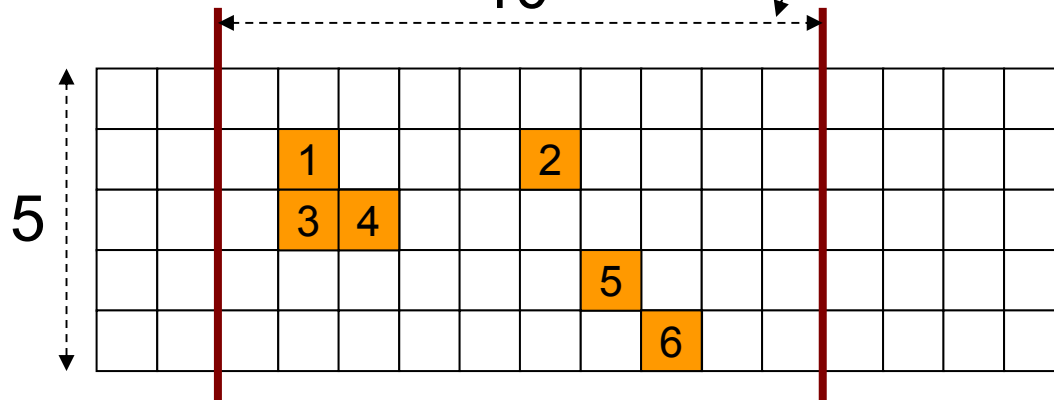


# Cracking rate



Surface cracking rate  
10

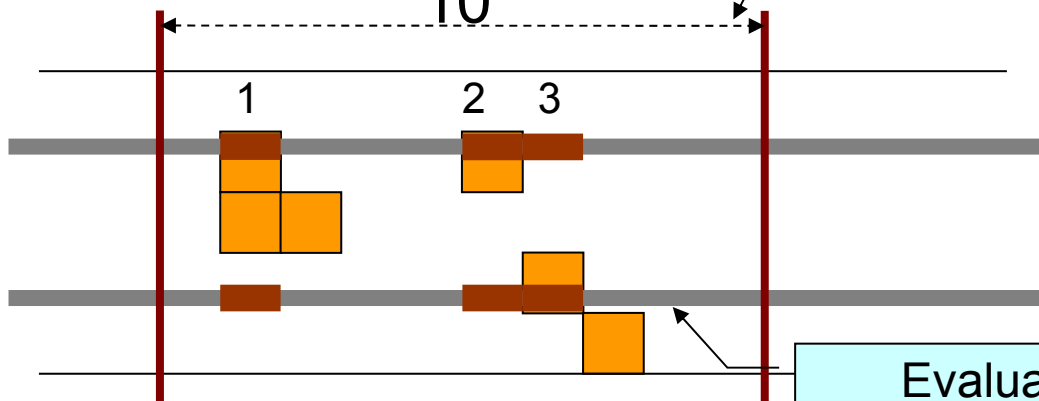
Square measure rate between road surface and cracking area



$$\frac{6}{10 \times 5} = 12\%$$

Wheel path cracking rate  
10

Distance rate between running distance and cracking distance



$$\frac{3}{10} = 30\%$$

Evaluate on wheel path  
(not include other surface)

# Combination Index



## PCR (Pavement Condition Rating)

$$\text{PCR} = (0.60 * \text{SCR}) + (0.40 * \text{RCI})$$

$$\text{RCI} = 160 * (2.718282 \wedge (-0.259776 * \text{IRI}))$$

$$\text{SCR} = 100 - [\text{Cracking rate}]$$

Pavement Condition Rating

Roughness Condition Index

Surface Condition Rating

0 (bad) ~ 100 (good)

---

## MCI (Maintenance Condition Index) Japanese Standard

$$\text{MCI} = 10 - 1.48C^{0.3} - 0.29D^{0.7} - 0.47\sigma^{0.2}$$

$$\text{MCI0} = 10 - 1.51C^{0.3} - 0.30D^{0.7}$$

$$\text{MCI1} = 10 - 2.23C^{0.3}$$

$$\text{MCI2} = 10 - 0.54D^{0.7}$$

smallest value is used.

C = Cracking rate [%]

D = Rut depth [mm]

$\sigma$  = JRI [mm]

0 (bad) ~ 10 (good)

---

Wheel path cracking rate is used for above formula.



# Web display samples



<https://map.bumprecorder.com/>

has  
3,809,790km data in global



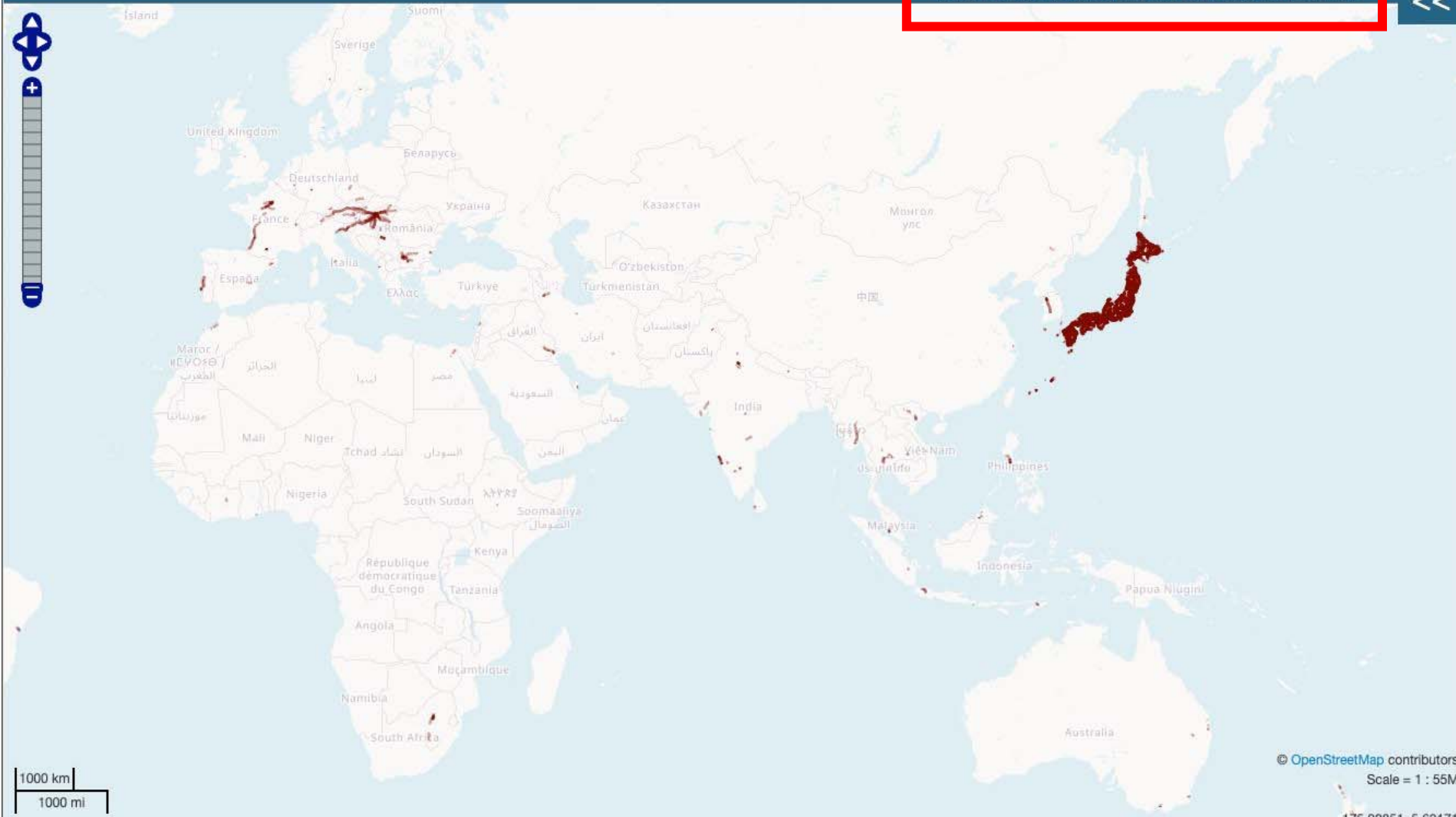
We have much experience!

# Whole Japan and many courtiers!



BumpRecorder Web    Data Download    PhotoReport    Other    Database    Free App    [?]    Get Free ID    Login

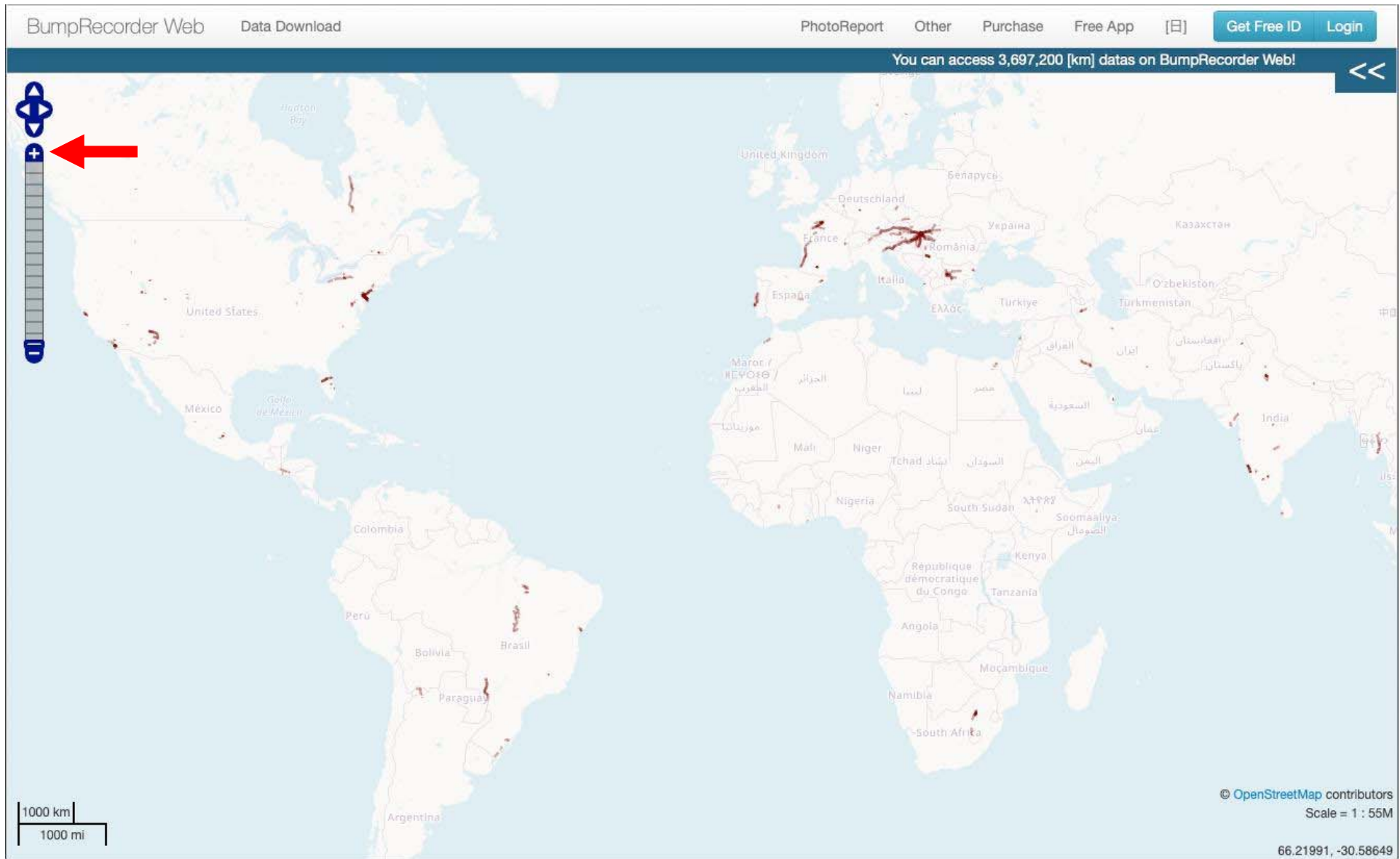
You can access 3,697,200 [km] datas on BumpRecorder Web!



1000 km | 1000 mi

© OpenStreetMap contributors  
Scale = 1 : 55M  
175.02851, 5.63171

# American continent too

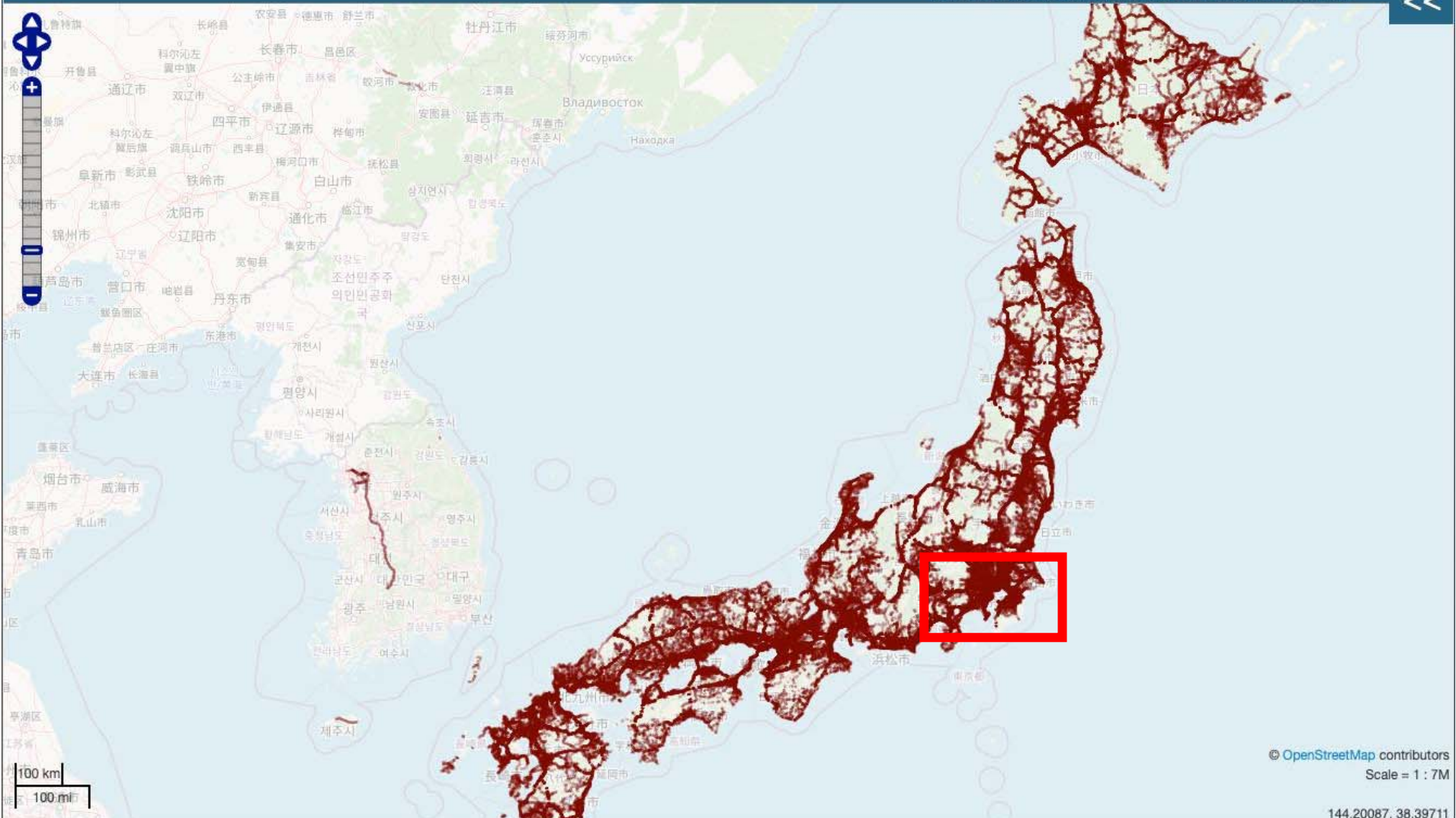


# Close up Japan



BumpRecorder Web    Data Download    PhotoReport    Other    Purchase    Free App    [日]    [Get Free ID](#)    [Login](#)

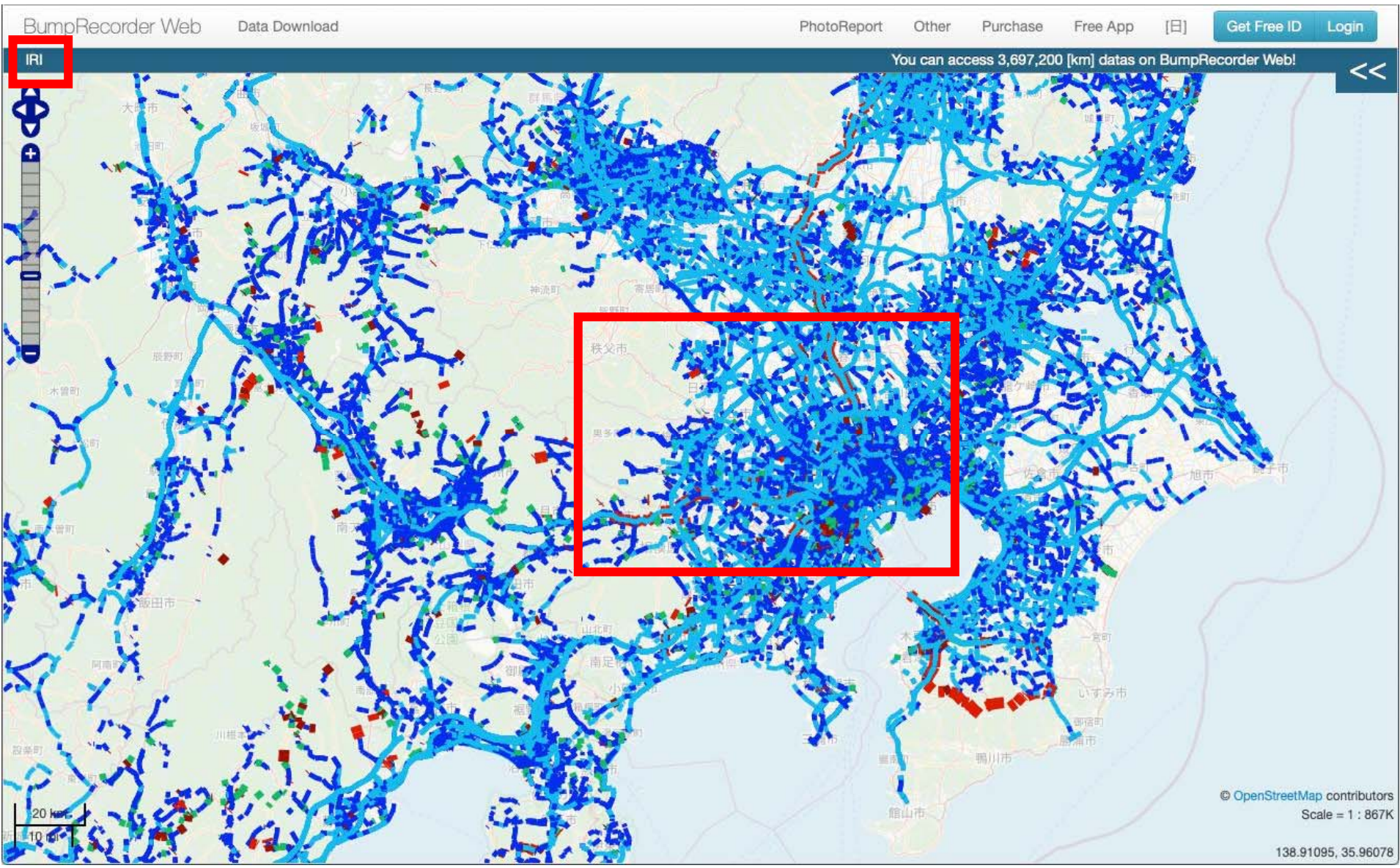
You can access 3,697,200 [km] datas on BumpRecorder Web! <<



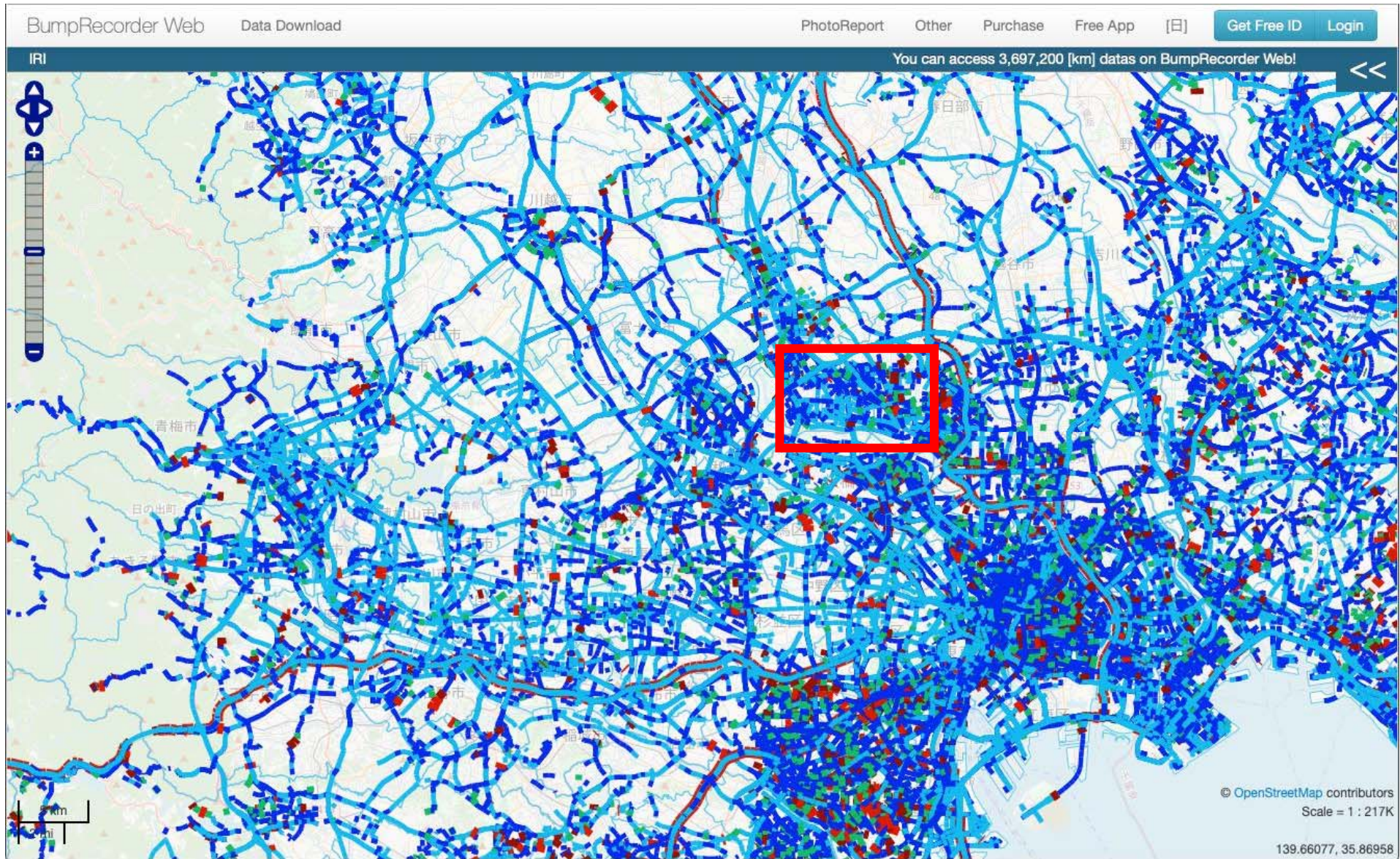
100 km  
100 mi

© OpenStreetMap contributors  
Scale = 1 : 7M  
144.20087, 38.39711

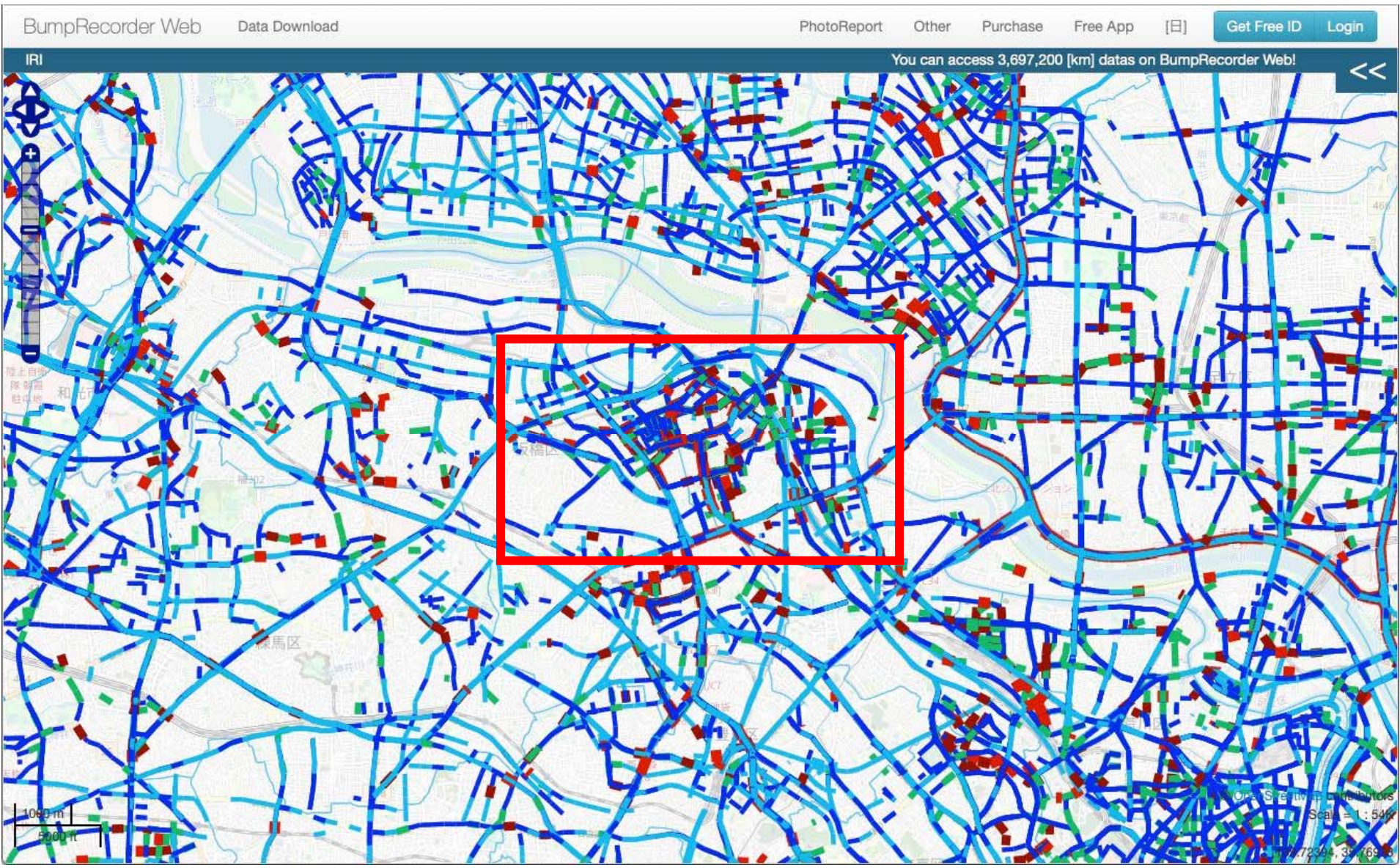
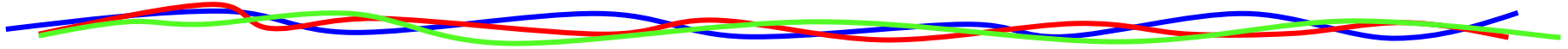
# Close up Tokyo area



# Close up more

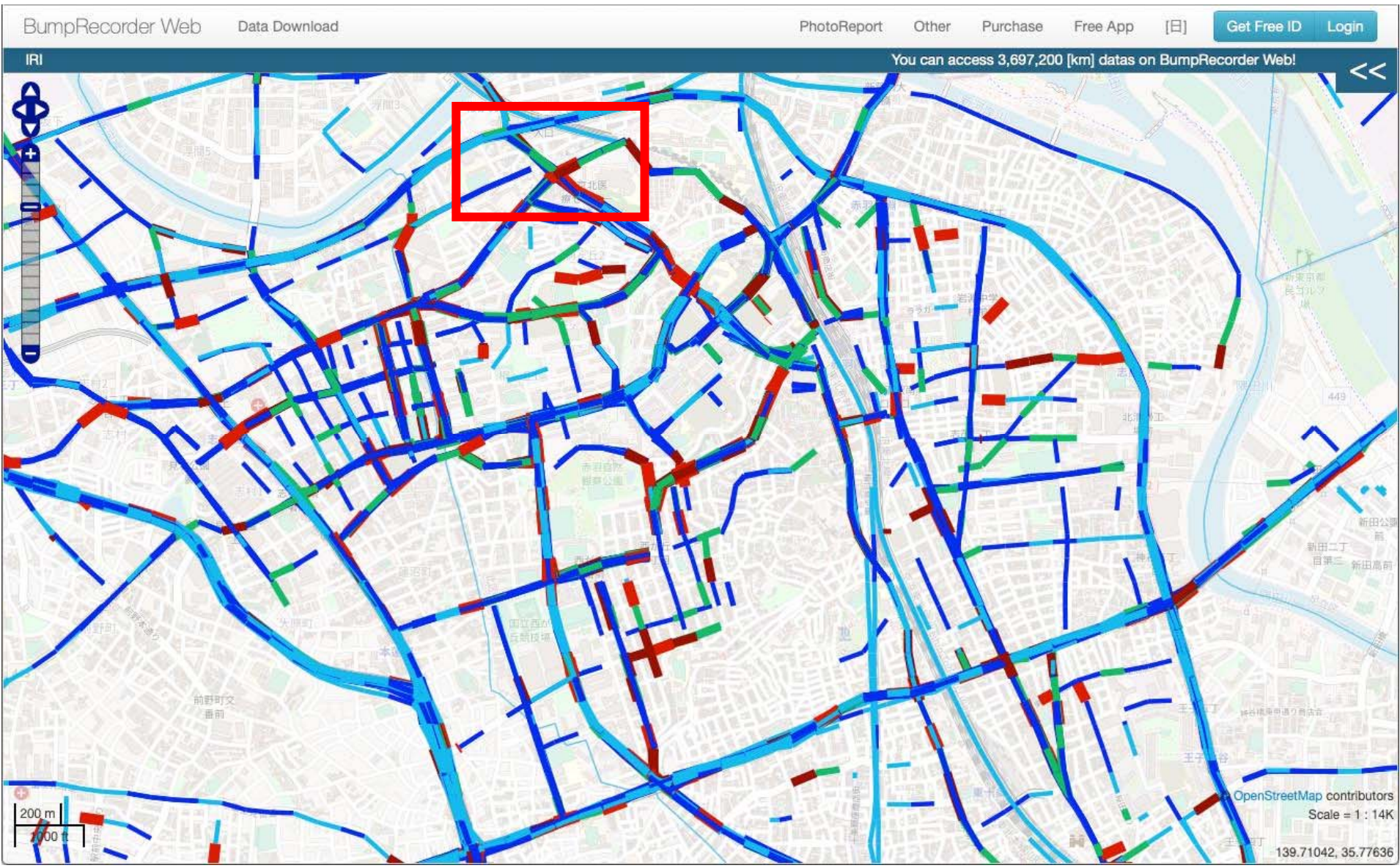
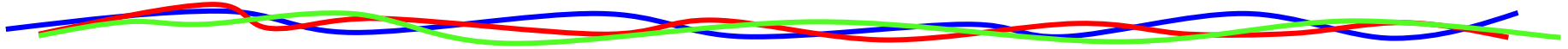


# and more

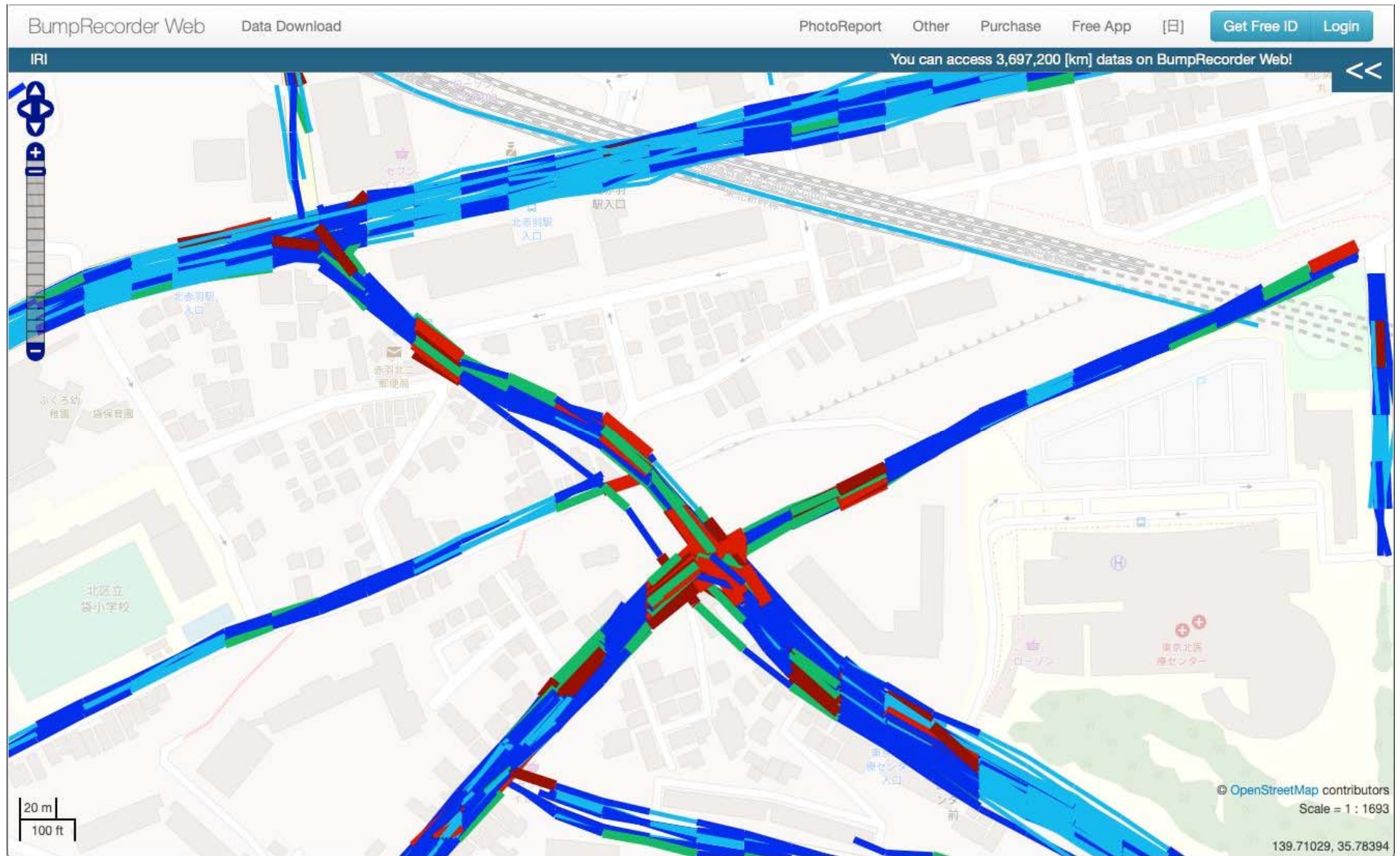




# and more



# Available from Network level to Project level



# Simple PMMS functions

-Pavement Maintenance Management System-



# Draw statistic graph

BumpRecorder Web for BumpRecorder Data Download

Global total:3,697,140[km]

Background map: OpenStreetMap Pro Version x

Search condition: from 2011-03-01 to 2020-07-29 Compare Measured by Shared My group My self Search

Drawing data type: GPS path Legend Class 3~10 Speed >= 20km/h IRI JRI Crack Linearity All Direction MCI PCR Speed LTx LTz Ax Az Bump(2m) (10m) (15m) Bump(Spring) Dashcam Photo

Area selection: Rectangle Polygon Line Modify

Position: Latitude Longitude Save Load

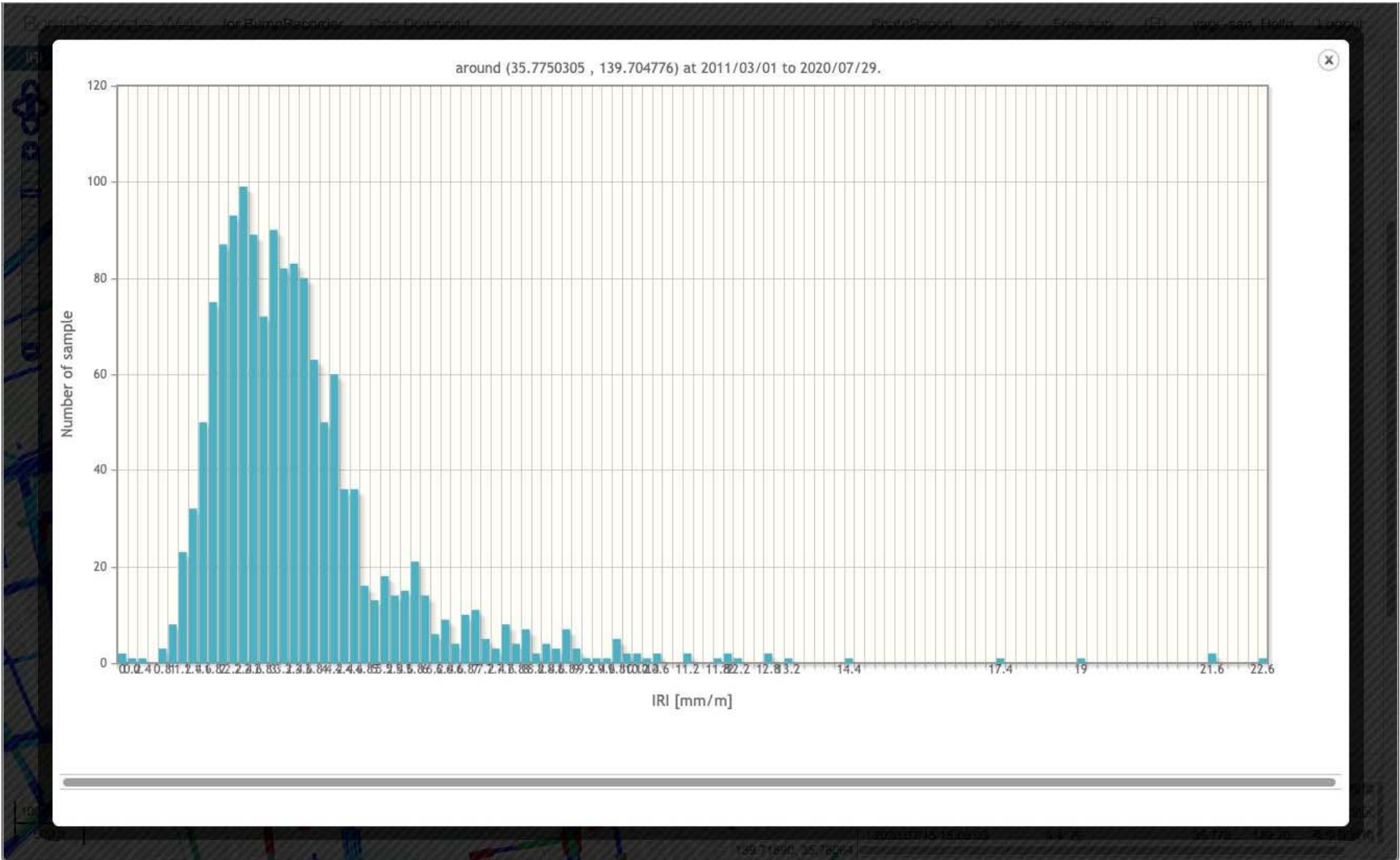
Position 2: Latitude Longitude Clear Distance=1497m

Analyze Type: Histogram at select point Analyze

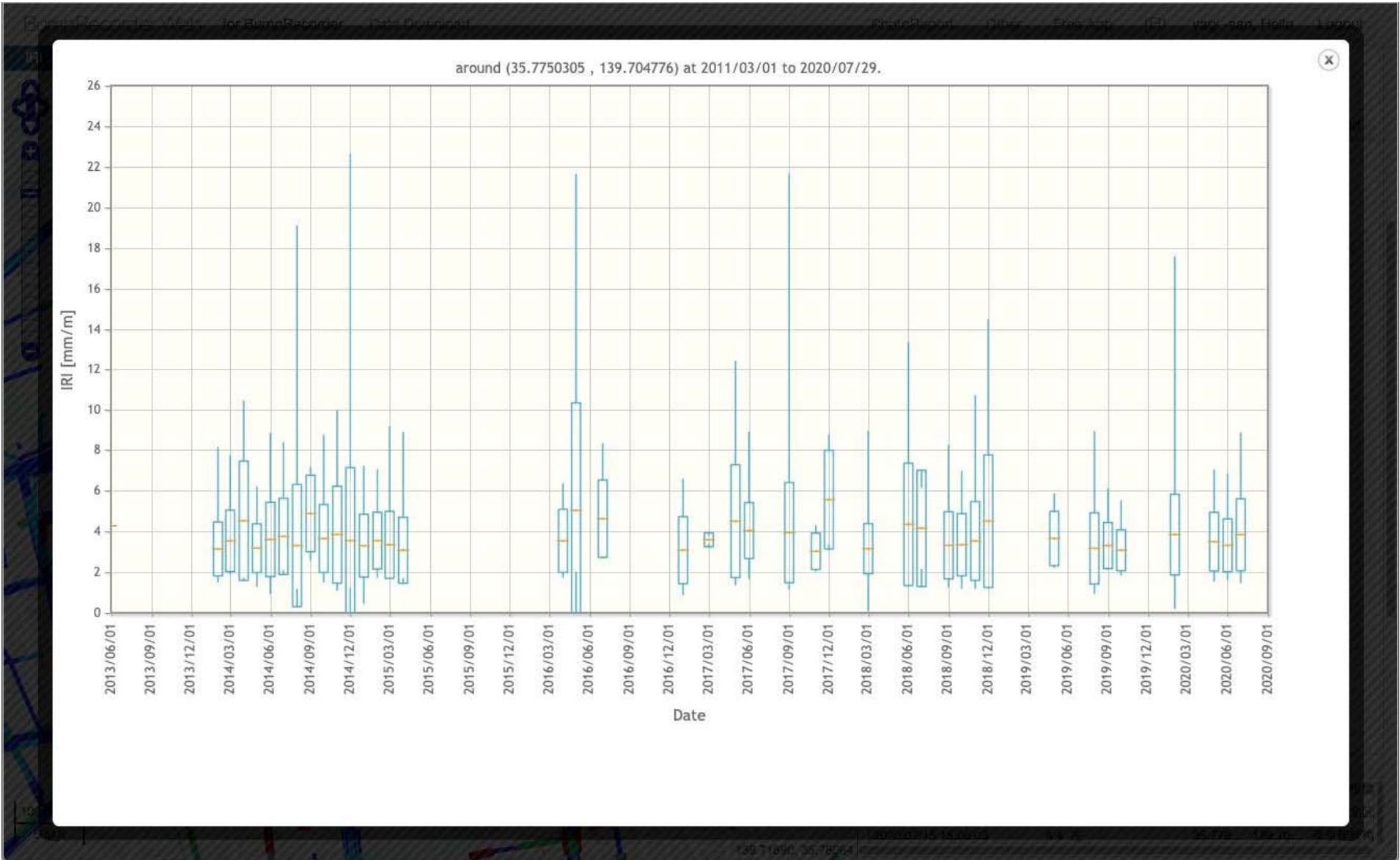
Data List

Date Time	Distance	Comment	Lat from	Lon from	Country
2020/07/16 10:22:28	2	左	35.778...	139.70...	東京都板橋
2020/07/15 16:11:09	2.5	左	35.782...	139.71...	東京都北区
2020/07/15 15:06:03	4.4	左	35.778...	139.70...	東京都板橋
2020/07/15 12:11:26	3.4	左	35.783...	139.71...	東京都北区
2020/07/15 08:43:01	2.5	左	35.778...	139.70...	東京都板橋
2020/07/14 15:43:58	4.8	左	35.778...	139.70...	東京都板橋
2020/07/08 15:06:19	5.7	左	35.778...	139.70...	東京都板橋
2020/07/08 12:10:12	2.0	右	35.781...	139.70...	東京都北区

# Histogram



# Time series



# Distance base

BumpRecorder Web for BumpRecorder Data Download PhotoReport Other Free App [日] yagi -san, Hello Logout

IRI Global total:3,697,210[km]

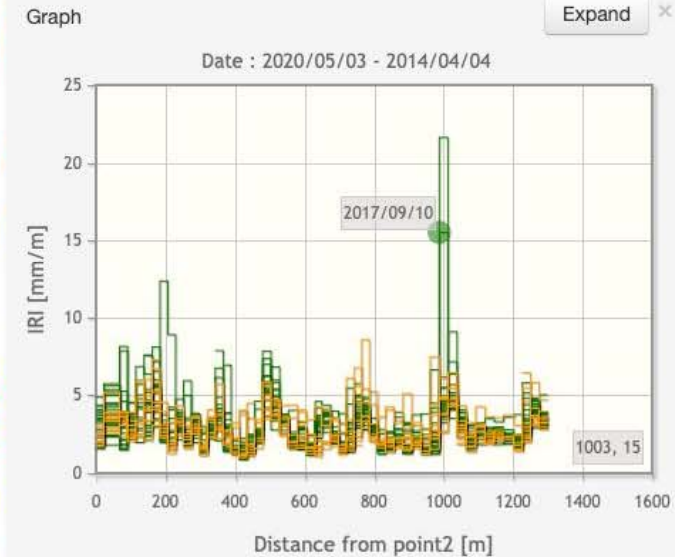
Area selection  Rectangle  Polygon  Line

Position 1

Position 2   Clear Distance=1,146m

Analyze Type Distance based graph between select Analyze

Graph Date : 2020/05/03 - 2014/04/04



Data List

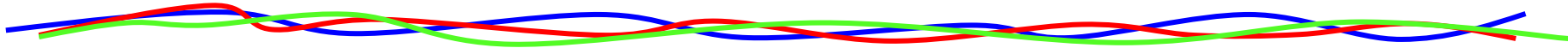
Search Result Latest Japan Latest Global

Date Time	Distance	Comment	Lat from	Lon from	Country
2018/11/25 16:55:31	8.2		35.776...	139.70...	東京都板橋
2018/11/18 17:56:38	9.1		35.776...	139.70...	東京都北区
2018/11/18 17:26:32	2.7		35.779...	139.70...	東京都板橋

Scale = 1 : 6771

139.71887, 35.78079

# Data comparison function





# Move to Comparison function

BumpRecorder Web for BumpRecorder Data Download

PhotoReport Other Free App [日] yagi -san, Hello Logout

IRI Global total:3,697,140[km]

Background map OpenStreetMap Pro Version x

Search condition  Pale

from 2011-03-01 to 2020-07-29 **Compare**

Measured by  Shared  My group  My self Search

Drawing data type

GPS path Legend Class 3~10 Speed >= 20km/h

IRI  JRI  Crack  Linearity All Direction

MCI  PCR  Speed  LTx  LTz  Ax  Az

Bump(2m)  (10m)  (15m)  Bump(Spring)

Dashcam Photo

Area selection  Rectangle  Polygon  Line

Position 1 Latitude Longitude

Position 2 Latitude Longitude Clear

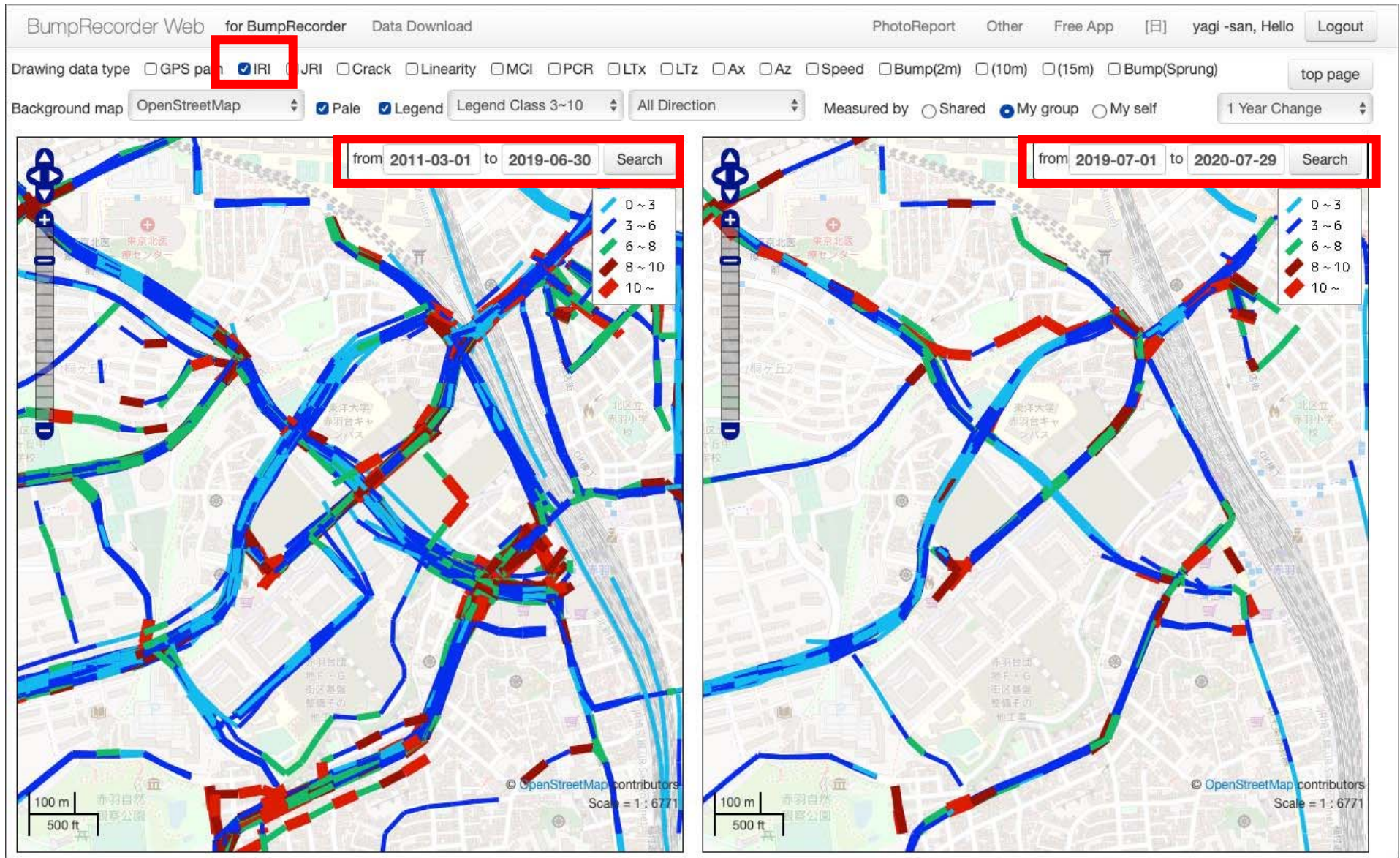
Analyze Type Histogram at select point Analyze

Data List

Search Result Latest Japan Latest Global

Date Time	Distance	Comment	Lat from	Lon from	Country
2020/07/16 10:22:28	2	左	35.778...	139.70...	東京都板橋
2020/07/15 16:11:09	2.5	左	35.782...	139.71...	東京都北区
2020/07/15 15:06:03	4.4	左	35.778...	139.70...	東京都板橋
2020/07/15 12:11:26	3.4	左	35.783...	139.71...	東京都北区
2020/07/15 08:43:01	2.5	左	35.778...	139.70...	東京都板橋
2020/07/14 15:43:58	4.8	左	35.778...	139.70...	東京都板橋
2020/07/08 15:06:19	5.7	左	35.778...	139.70...	東京都板橋
2020/07/08 10:10:13	2.0	右	35.781...	139.70...	東京都北区

# Same location, different period



# Crack



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Drawing data type  GPS path  IRI  J  Crack  Linearity  MGI  PCR  LTx  LTz  Ax  Az  Speed  Bump(2m)  (10m)  (15m)  Bump(Spring) top page

Background map OpenStreetMap  Pale  Legend Legend Class 5~20% All Direction Measured by  Shared  My group  My self 1 Year Change

from 2011-03-01 to 2019-06-30 Search

0 ~ 5  
5 ~ 10  
10 ~ 15  
15 ~ 20  
20 ~

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from 2019-07-01 to 2020-07-29 Search

0 ~ 5  
5 ~ 10  
10 ~ 15  
15 ~ 20  
20 ~

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# MCI



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Drawing data type  GPS path  IRI  JRI  Crack  Linear  MCI  PCR  LTx  LTz  Ax  Az  Speed  Bump(2m)  (10m)  (15m)  Bump(Spring) top page

Background map OpenStreetMap  Pale  Legend Legend Class 2~8 All Direction Measured by  Shared  My group  My self 1 Year Change

from 2011-03-01 to 2019-06-30 Search

0~2  
2~4  
4~6  
6~8  
8~

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from 2019-07-01 to 2020-07-29 Search

0~2  
2~4  
4~6  
6~8  
8~

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# Any Questions? Requests?

We are always welcome your contact!

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